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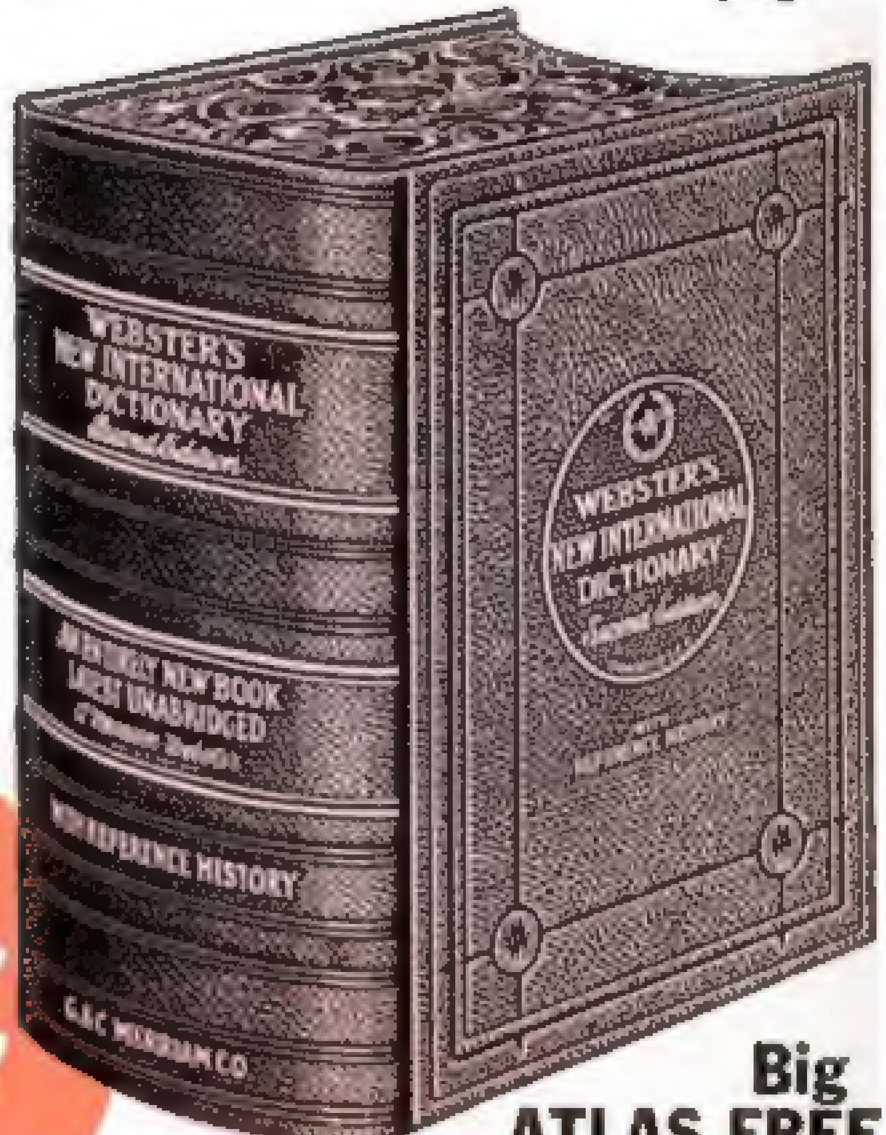

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POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 141 NO. 3

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS for SEPTEMBER, 1942

News

Automobiles

Home and Workshop

Departments

(Contents continued on page 4)

COL. ROYAL B. LORD ("Cargo Planes for Victory," page 66) is an Army Engineer whose thought is playing an important part in shaping America's war policies and strategy. As Assistant Director of the Board of Economic Warfare, he is making great contributions to hemisphere solidarity. His inventions for the U.S. Army, the Lord Portable Steel Machine-Gun Emplacement and the Lord Portable Military Cableway, were described in previous issues of this magazine. An authority on low-cost housing, he developed modern methods of construction with prefabricated panels while serving as Chief Engineer of the Resettlement Administration by personal appointment of President Roosevelt.

EDITOR . . . . Charles McLendon
MANAGING EDITOR . George H. Waltz, Jr.
HOME & WORKSHOP EDITOR Arthur Wakeling

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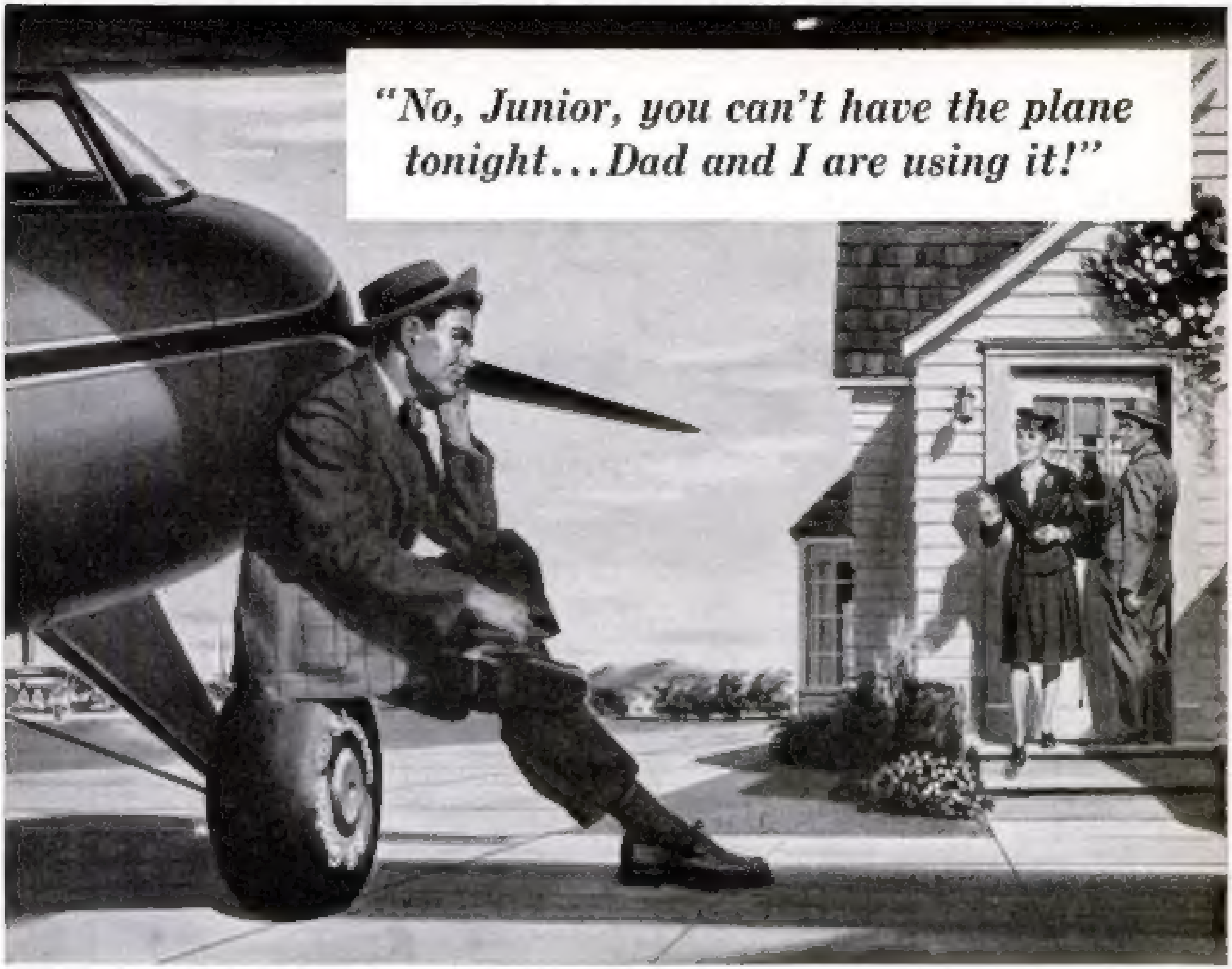

DON'T feel too sorry for Junior. Life in the America that lies ahead has other compensations. In fact, it will be so far superior to what his parents had at his age, their fondest hopes will seem meagre, their deepest dreams will seem trivial.

It's not hard to imagine a family plane. Many were flown before the war. American manufacturers have blueprints of them for larger production when peace comes. It's not hard to conceive of hourly air travel to distant continents. Our ferry command is doing just that today. It's not hard to believe in fleet upon fleet of flying freighters when we're turning out gigantic bombers by the thousands right now.

Is this new America a dream? Yes, in the sense that its wonders reach into the depths of man's imagination. No, in the sense that it is real and inevitable. For the men who are planning and building the planes of Victory *now* will soon be planning and building the planes of Peace.

Out here at B. F. Goodrich our Aeronautical Division has been making dreams come true for over 30 years. We've played our part in the miracles of aviation with Silvertown Tires that make a plane's landings safer and smoother, with Expander Tube Brakes that give pilots greater ground-control, with De-Icers that defy the elements.

Naturally, most of the 80 B. F. Goodrich aviation products we turn out today are being used by Uncle Sam. We're proud of this. Every B. F. Goodrich employee knows that what he makes goes to create a plane that is the world's best. One reason he's doing his job today faster and better than ever is that he too wants to get started building the new America. The B. F. Goodrich Co., Aeronautical Division, Akron, Ohio.

Contents (CONTINUED)

Aviation

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Photography

Craftwork

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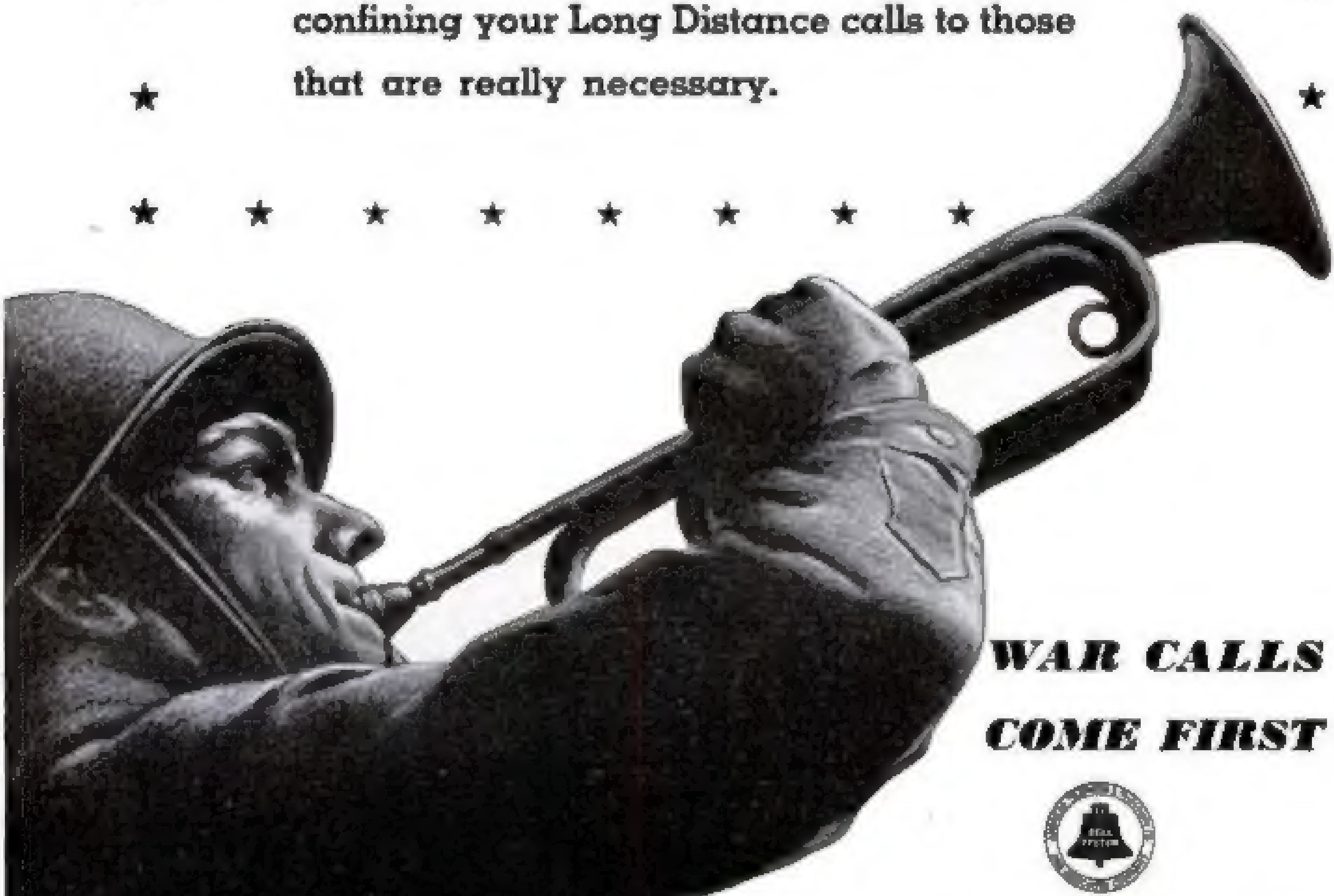
Clear the Lines for the War

Before you make a Long Distance telephone call today, ask yourself these questions:

1. Is it necessary?
2. Will it interfere with war calls?

The weight of war on the telephone lines is heavier every day. We can't build the new lines to carry it because sufficient materials aren't available. We've got to make the most of the service we now have.

Please give a clear track to the war effort by confining your Long Distance calls to those that are really necessary.



WAR CALLS COME FIRST

BELL TELEPHONE SYSTEM

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Notice to Subscribers in the Service

WE RECEIVE many letters from subscribers in the armed forces asking for change of address when they are transferred to new posts. In some cases, censorship does not allow them to give the address to which the magazine is now being sent. To enable us to locate the subscription, such subscribers are requested to give the line of key information at the top of the stencil address on the wrapper of the magazine. With this information, we can correct our mailing list and insure continued receipt of copies insofar as it lies within our power to do so.

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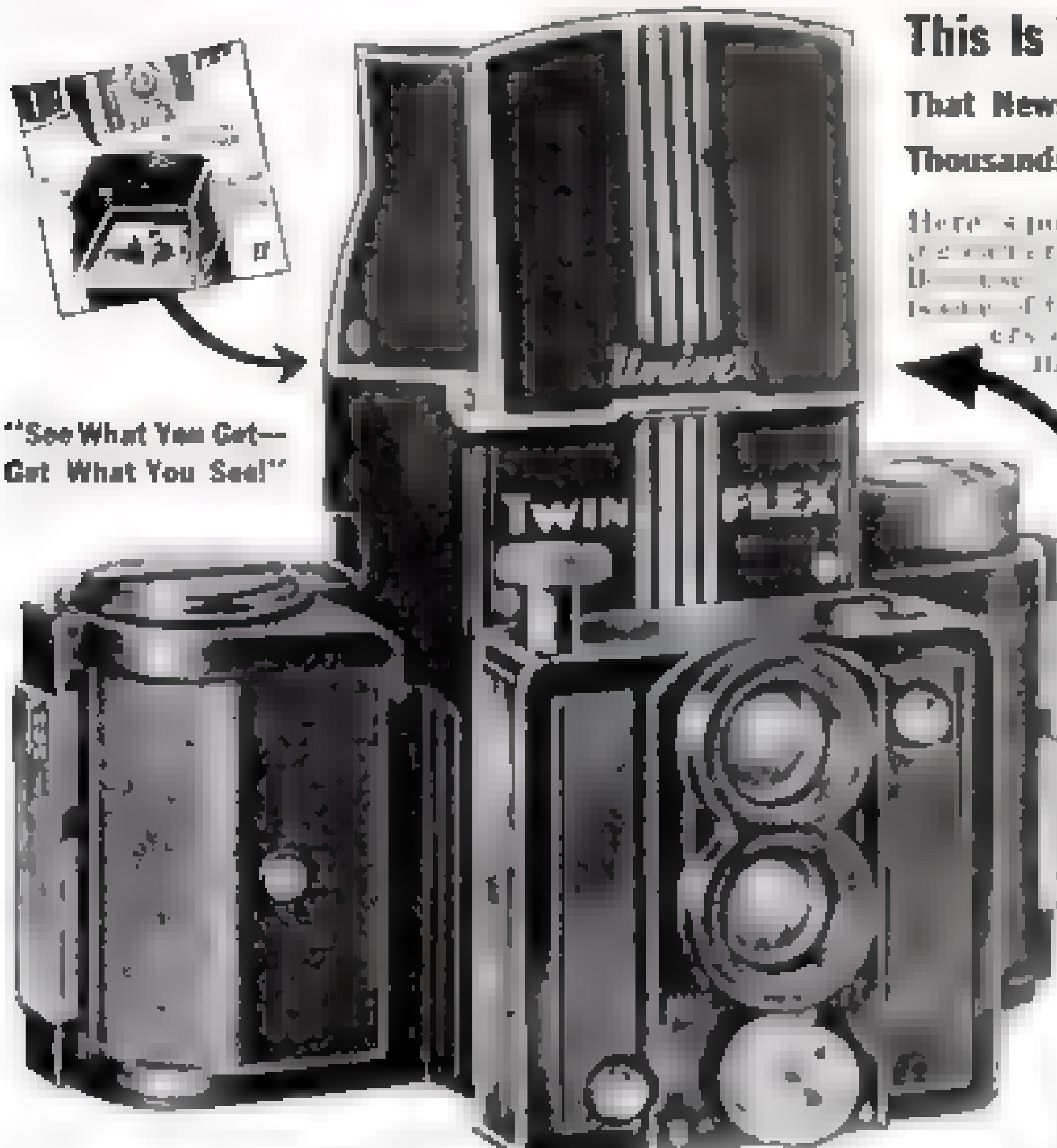

This Is The Type Camera

That News Photographers Use.

Thousands Paid $5.50 For It!

Now Only $2.98 Film FREE

Here's positively the most amazing camera bargain ever offered! Because the manufacturer, who is one of the world's largest makers of cameras, is engaged in the manufacture of war materials, we have purchased the last few thousand TWIN FLEX Reflex Cameras at a "close-out" price. A few months ago this camera was being sold by camera dealers at $5.50. In the face of sky-rocketing prices, a few thousand lucky camera fans can own one of these genuine $5.50 TWIN FLEX Cameras for the unbelievably low price of $2.98. This marvelous camera, with its matched focusing lenses, shows you the actual picture on the ground glass range finding screen *before* you take the picture. You can tell *exactly* the way each and every picture will look before you snap it. There is no squinting through small view finders! No out-of-focus pictures, whether the subject is close up or far away.

Amazing Matched Focusing Lens Prevents "Duds" or Blurry Shots

Even at the old price of $5.50, the Univex TWIN FLEX was the sensation of the camera world. This marvelous camera, with its matched focusing lenses, shows you the picture on the ground glass range finding screen *before* you take the picture. In other words, you can tell *exactly* the way each and every picture will look before you snap it. You automatically focus every picture before you take it. There is no squinting through small view finders! No out-of-focus pictures, whether the subject is close up or far away! *YOU GET EXACTLY WHAT YOU SEE!*

This TWIN FLEX Comes To You On A Money Back Guarantee of Satisfaction!

TWIN FLEX Has Many Features Found in $35.00 Cameras

So confident are we that you won't be able to duplicate this camera "buy" anywhere else in the country, that we will gladly send it to you along with a FREE roll of film, on our no-risk money-back guarantee. If after getting and using the TWIN FLEX for ten days, you and your friends don't think that this is far and away the most amazing camera bargain you have ever seen, just return the camera (keep the film) and we will refund your money—every penny of it! The price is only $2.98 for the camera! The film comes to you *ABSOLUTELY FREE!*

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☐ Send rolls of film C.O.D. for $1.00 plus postage.

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☐ Enclosed find $3.98. Ship me all postage paid 1 Camera and roll of film and 7 extra rolls of film, enough for 48 pictures. Include Photo Album FREE.

Coming Next Month—

NAVIGATING a bomber through windless seas of air to known, fixed objectives would be a cinch. But there is no windless air four miles up, and objectives may not stay fixed. You'll get about as close to the problems and realities of the bomber navigators in the authoritative story coming up as you could without becoming a navigator yourself—and there are interesting facts on that, too.

WHEN YOU STRIKE a paper match, you have touched an important subject. It is phosphorus, a vital war material. Because it is part of innumerable metal alloys and of many more chemicals of both peace and war, its current production rate is heartening for its wartime value, and it will be invaluable to us after the war. An article explains why.

PHOTOGRAPHING CHILDREN, from the diaper to the teen-age, is a tricky business. What props to use? How to get them to pose? What lights to employ? These are just a few of the problems answered by a Hollywood director with an impressive professional and amateur background of success with the kids. It's an article that every camera clicker should be exposed to!

INVENTORS have as much to do with winning a modern war as the soldiers in the firing line. For America's great war effort, the professional research men have been organized and put to work under Government control. The independent inventor can help, too, and a timely article gives him some practical hints on putting his talent to work to serve his country.

EVEN THE BEST lathe dog will sometimes bite the hand that feeds it. An effective way to muzzle it, as well as to decrease the danger of injury from other revolving machine-tool parts, is protecting many defense workers in our arms plants. Called "High-Lighting Machines," the system works as well in your home workshop as in heavy industry. A startlingly simple safety and work-speeding plan!

IF YOU GET A FLAT TIRE miles from help, and you carry no spare, what do you do next? We figured that countless drivers would want to know. In step-by-step photographs, abundantly captioned, we show and tell you how to change and repair a flat tire unassisted by the labor-saving gadgets of the professional. Better start looking around now for an old fashioned hand-type tire pump. One of these days, they won't be easy to get!

From the News Editor's Desk

BEEF BLOOD may be used to treat shock in the future if scientists are able to prepare beef albumin in such a way that it will be harmless when injected into man. Research workers at Harvard University are working intensively to utilize the millions of gallons of beef blood now thrown away each year at slaughter houses. Albumin from human blood showed dramatic results in the treatment of shock at Pearl Harbor and has been used effectively in civilian hospitals. In cases of shock, the blood vessels lose their capacity to hold fluids within their walls, a condition that the albumin counteracts.

RARE INDIUM may replace war-restricted tin as a lining for toothpaste and shaving-cream tubes. Until 1924, only one gram of indium had been prepared in pure form, although since that time an American corporation has been extracting it from ore, a large deposit of which was found in Arizona. Only a very thin coating of the precious metal would be needed in lead tubes to protect the contents.

DESTRUCTIVE TERMITES can be kept out of buildings by pouring discarded lubricating oil at every point where the building touches the ground. Prof. J. C. Cross, of the Texas College of Arts and Industries, Kingsville, Tex., stated that he poured discarded oil into little ditches dug around each of 56 concrete piers holding a house foundation. Although the ground was infested with termites at the time the oil was poured, the house has been free from them since it was built in 1938.

SUGAR CANE is taking the place of cork as a cold-storage insulating material. From the fibers remaining after the sugar juices have been squeezed from the cane stalks, a large corporation is now making an insulating material that is said to be equally as good as cork board. The material is made by weaving selected lengths and thicknesses of the cane fibers and felting them into half-inch insulating boards of a special low density.

INDUSTRIAL WORKERS can prevent heat cramps and heat exhaustion by taking vitamin C, according to Dr. John H. Foulger of the Du Pont Company's Haskell Laboratory of Industrial Toxicology. This vitamin, explained Dr. Foulger, is apparently needed to maintain muscle tone which helps move the blood in the veins back to the heart. In heat prostration, there is a loss of tone and a consequent collapse of the circulation. Thirty men who had taken doses of vitamin C were recently put on a repair job where the temperature was far above 100 degrees F. When the job was finished, all the men reported feeling just as fit as when they had started working. Vitamin C has also proved effective in treating heat prostration when it does occur.

Readers Say:

Tell the Automobile Makers What Kind of Car You Want

THE general impression of automobile writers in the past few weeks has been that the postwar automobile will be a real scientific improvement; that designers and manufacturers, released from the necessity of creating a yearly fashion along conventional lines, will create a scientifically designed vehicle incorporating the ideas they long had but feared to spring on the public. I think this is quite true. Drivers will be so tired of the worn-out, ancient jallopy that they will welcome a completely new automobile of radically different design. Aviation designers will undoubtedly influence that design. Newly developed plastics and light metals will be used. The engine will move to the rear where it belongs. Seating arrangement, vision, comfort, safety—all are in for a renaissance. But these things are generally recognized by most modern people. I think it is up to them to influence publications like POPULAR SCIENCE to report and promote this trend. Several years ago you ran a contest to get the public's ideas of the car of the future—and the car they would like to drive. I think now is the time to print more of these designs to let the manufacturers know what we want—and that we will not be content with cars like those we drove before the war. —Pvt. W. C. R., U S. Marine Base, San Diego, Calif.

Three "Unconnected" Ideas —All Connected with War

HERE are three unconnected thoughts I have captured: (1) How about an article on the operation of cars, trucks, and tractors on wood gas—or better, for this locality, coal gas? (2) Has a test been run on the fruit of the Osage orange as a source of rubber? Millions of tons of them fall on the ground every year. The juice looks like milkweed and is *very* sticky. Better get started on this; they start dropping soon. (3) An air raid by enemy planes carrying U. S. insignia: how would they be detected before they reached some vital spot?—K. W. G., Grand Junction, Colo.

Vacuum-Bottle Idea Is Screwy, This Housewife Says

So F. L. A. is going to save his wife's temper by left-threading his vacuum-bottle body so it won't come apart when he unscrews the cap at his midshift lunch time! What a thoughtful fellow! Then when wifey tightens the cap in packing the lunch, the body thread comes apart and cuts *her* hands. Don't you wish you had a screwy husband like that—or do you?—Mrs. W. C., Oak Park, Ill.

Here's More Old-Time Equipment Still Giving Good Service

YOUR article on old-time shop equipment in your Seventieth Anniversary Issue was specially interesting to me because I have some equipment of this kind, including an F. E. Reed foot-power screw-cutting lathe. It cuts from 10 to 48 threads per inch, has a 10-inch swing, and is 26 inches between centers. It pumps surprisingly easy, but I plan to motorize it soon. I also have a cast-steel screwdriver similar to the one you pictured. It was made by Knapp & Cowles. On several occasions I have used a wrench on it to loosen stubborn screws, and I must say it can take it. I think you have a grand magazine, and I have taken this opportunity to show my interest in it.—R. G. R., Waukegan, Ill.

We Still Think That Tripping Is the Surest Method

WHEN I patronize restaurants after dances and at other rush times, I notice that they are very short-handed and it is difficult to get the attention of a waitress without either tripping her or staging a minor riot. Why not have each table provided with a pennant on a short pole with a base, which could be set upright as a signal for service? When not in use, it could be laid flat on the table. This idea should be specially attractive to the nautical-style beach clubs. Of course, the pennant could be chained to the table to discourage souvenir hunters.—E. J. C., Philadelphia, Pa.

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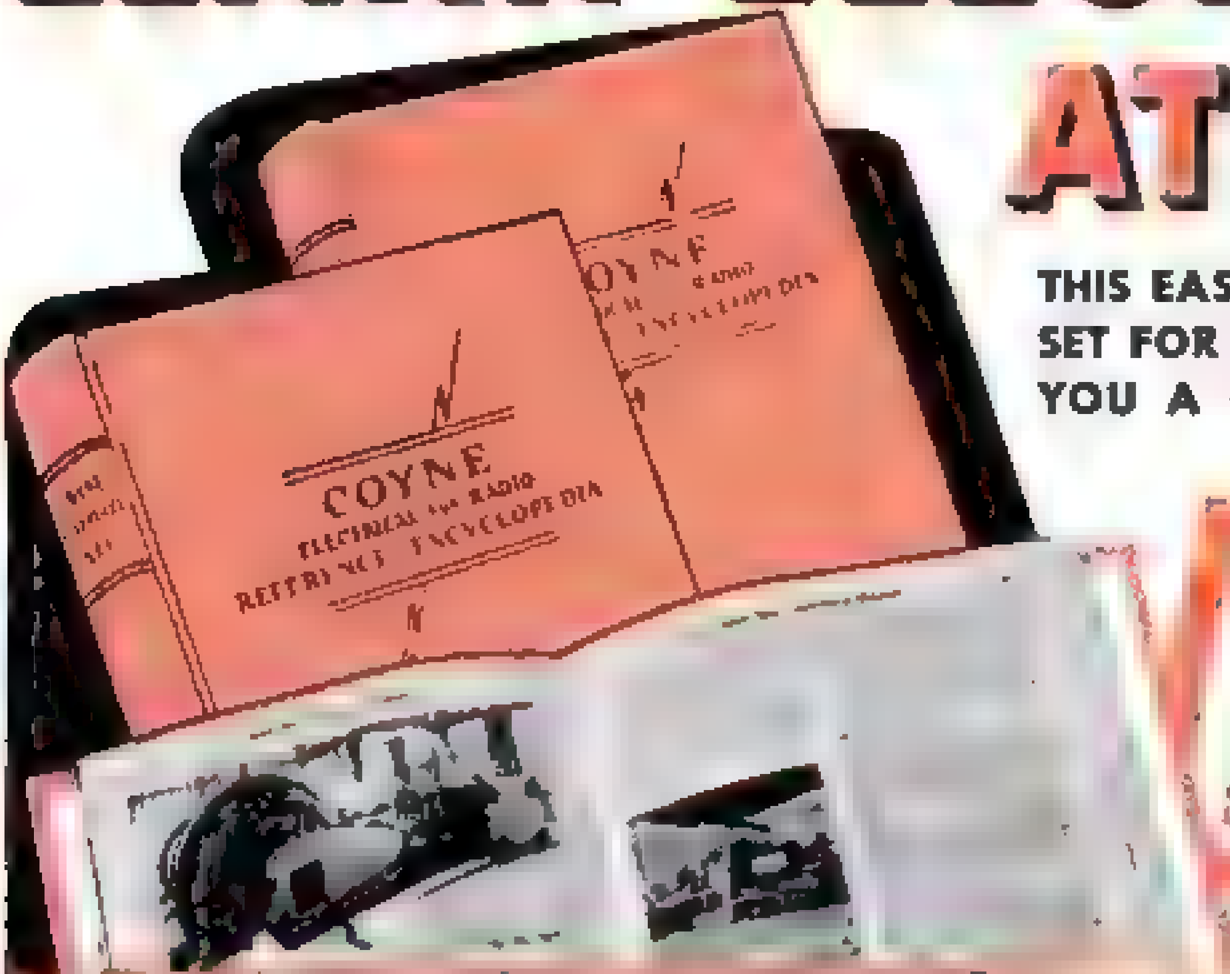

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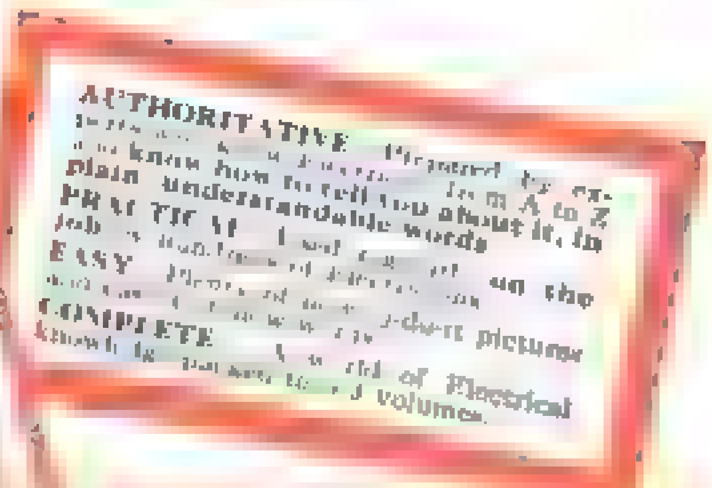

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Readers Say:

Home Chemists Want a Part in War Production Work

IN RECENT issues of P. S. M., much has been said about home craftsmen and their part in the war production program. I wonder if there isn't something that home chemists can do in the way of research or related problems. I am sure that there are many all over the country who would be willing to aid our country in any way possible—E. J. S., Davenport, Iowa.

Mother's Favorite Sulfa Drug Is Still Sulfa 'n' Molasses

I WAS deeply interested in your article on the sulfa drugs and read it to my mother. When I finished the article she said "Hmph, I still like sulfa 'n' molasses better." Tell J. A. his farmer ought to go to the store and buy himself a better tape measure. —G. R. G., Marfa, Tex.

Seagoing Machine Shops Might Help in War Work

HAVING read about your registering home workshops for war work, I have a suggestion which may help you. Most ships in the American Merchant Marine carry from four to nine marine engineers as crew members. They work eight hours a day and have little to do the other 16 hours. Some do no work on Saturday afternoons, Sundays, and holidays. The average ship has a lathe, drill press, and other shop tools which could be pressed into service if some agreement could be made with the steamship companies. Many of these ships, such as colliers and tankers, sail coastwise. Many of the marine engineers are good machinists and could turn out quite a bit of work in their spare time aboard ship if given the opportunity. Also, most of the time these floating workshops have nothing to do; they are here to make emergency repairs if needed. In fact, although I studied shop work at a school in New York in 1937, I haven't used a lathe in so long that I'm a bit rusty.—G. S. B., S. S. *Edward Pierce*

Readers Say:

That's What Sir Walter Raleigh Got—and He Didn't Have a Robot

In a recent issue you described an invention of a "robot fireman." The inventor claims that if the robot sees a flame, it will squirt a stream of water at the fire. But suppose a smoker should light a cigarette in the presence of the robot—wouldn't he get a thorough wetting?—B. T. W., Jr., Franklin, Va.

This Reader's File of P.S.M. Goes Back to the Beginning

As you are celebrating the seventieth anniversary of P. S. M., I thought you might be interested in knowing that I have Volumes I to VII inclusive, bound in green leather and cloth and in brown leather and cloth. They are in perfect condition, with the paper white and the bindings hardly marred. Aside from several years in Los Angeles, they have never been over a few hundred feet from their original place. They were purchased by my father when he was a young man.—B. R. R., Kokomo, Ind.

Circular Saw Shows Stroboscopic Effect Under Daylight

In your "Readers Say" section I noticed that E. S. observes a stroboscopic effect of a drill in a drill press as it slows down to a stop under an alternating-current light. I would like to inform him that I have seen this in connection with a circular saw whose belt was slipping a bit. When the board was shoved in fast, the saw would slow down until it seemed to stand still with each tooth plainly visible. A certain point would be reached when the saw appeared to be going slowly backward. The strange part was that this effect was visible by daylight. My explanation is that the whole saw actually stopped for a fraction of a second as each tooth took hold, and when the correct speed was reached the teeth seemed to stand still because of the persistence of vision.—R. H., Clinton, N. J

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FROM mosquito boats to battleships, war vessels today occupy the spotlight of world events. Why not bring your model collection up to date with authentic miniatures of fighting ships? A good beginner's kit is our No. 9M, which builds a 12¾" model of a United States destroyer, and is priced at one dollar. The 20" model of a 160' Canadian corvette shown above was built from our kit No. 16S ($6.75†). Kits for a motor torpedo boat and a battleship are listed below.

For an illustrated list of all our construction kits, send a stamped, self-addressed envelope.

6M.	Fishing schooner WE'RE HERE, 9¼" long	$ .85
8M.	Racing ketch, planked hull, 18" long overall, 2¾" beam, sails included	1.60
9M.	U. S. destroyer, Mayo class, 12¾" long, (finished capstan and anchors)	1.00
R.	Battleship U.S.S. TEXAS, 3' long, scale 1/16" equals 1'	7.95*
V.	Clipper SOVEREIGN OF THE SEAS, 20¼" hull, 26" overall. Kit includes anchors, flags, bell, capstan, brass ladder	5.35†
8S.	Fishing schooner BLUENOSE, 17½" hull, scale, ⅛" equals 1'. Kit includes anchors, wheel, bell, flags, mast rings	6.30†
9S.	New Bedford whaleboat, with complete equipment, 14" long, scale, ½" equals 1'	2.95†
13S.	Motor torpedo boat P.T. 10, a 13" exhibition model, shaped hull, propellers, etc.	5.00†
7.	Whittling kit with two blocks for making sea captain 6½" high	1.60

Note: If you live west of the Mississippi River, add 50 cents to price marked with an asterisk (*) and 25 cents to prices marked with a dagger (†).

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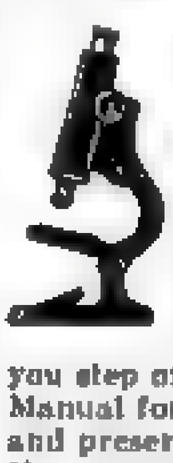

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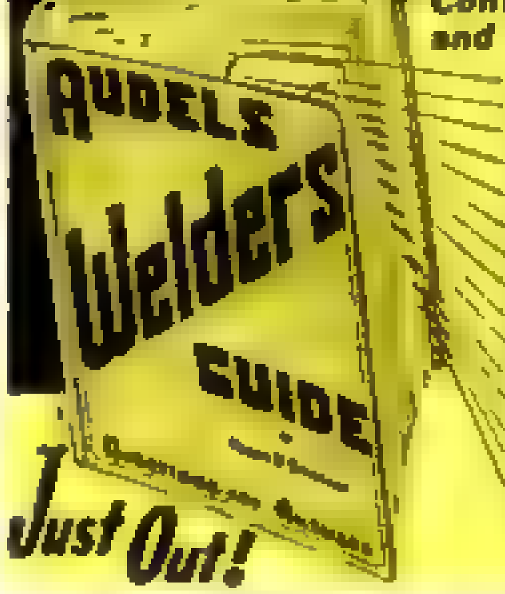

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OLD-Fashioned Maple Sweets. Syrup, $3 gallon, $1.75 half-gallon. Sugar cakes, $.75 pound; four pound cakes $2.60. Soft sugar in five pound can, $3. Sent express collect. Forest Farms, Jamaica, Vermont.

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24 LAWN Ornament patterns 25c. Other patterns, 15"-20" high. Dutch girl, Dutch boy, pirate, bull terrier, Mexican girl, Mexican boy, dwarf, [illegible] girl, 10c each, 3 for 25c. 23 Novelty patterns, 30c. All 42 full size patterns $1.00 postpaid. [illegible], Box 343-DV, Bellingham, Wash.

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INVENTIONS wanted—Now assembling line to present after the duration. Do you have an item of merit with national distribution possibilities? We have capital to manufacture and contacts to market items selected. Have successfully sold under HE-O Trademark to 10c Store Chains and Catalog Houses for years. If you have an item with Chain Store appeal communicate with us at once. Address New Products Dept., Heckethorn Mfg. & Supply Company, Littleton, Colorado.

INVENTORS: Small manufacturers need new inventions for altered civilian markets. If you have a practical useful idea for sale, write Chartered Institute of American Inventors, Dept. 3-C, Washington, D.C.

MACHINE shop is in the market for patented or unpatented ideas or inventions to manufacture after the war. Send drawings and all information to Mechanical Department, 2035 Washington Avenue, Philadelphia, Pa.

AIRPLANE instrument, photographic and Optical Inventions wanted. Outright purchase or manufacture on royalty basis. Verschoor Corp., Box 624, Ann Arbor, Mich.

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LEGAL DIRECTORY

MEXICAN Legal matters. Wm. Cocke, Reliable Amer. A[illegible], El Paso, Texas.

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RECLAIM dull and broken drills with No-Way Drill Grinder. Circular free. Tractor-Lite Mfg. Co., Sidney, Iowa.

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WORLD'S largest professional magic shop keeps you in touch with latest tricks. To receive mailings send 25c for 1942 catalog. Holden's, [illegible] W. 42nd St., New York.

MAGICIANS' Gamblers' secrets exposed. Cards, Dice, Punchboards, [illegible]. Catalog 10c. Book Co., Box 671, St. Louis, Mo.

AMAZE Audiences! Become Professional Magician! Dollar Trick, Catalogue, Circulars, Dime. Nelmar, 3831 Milwaukee, Chicago.

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Color Prospecting

SIMPLE PROCESS HELPS GET MORE METAL FROM MINES

By ALDEN P. ARMAGNAC

TINY patterns of red, blue, green, and other hues, produced on small disks of paper, now yield the innermost secrets of valuable and strategic ores. Worked out by Dr. Gregoire Gutzeit, Russian-born chemist and metallurgist, while a university professor in Switzerland, and developed here into a practical tool, this method of "color prospecting" aids industry today at the Westport, Conn., laboratories of The Dorr Company, prominent chemical and metallurgical engineers and makers of processing equipment.

Use of the new process shows the richness of a sample of ore, in virtually any metal; in what particular chemical compound the metal appears; how it is distributed through the ore—in big lumps or microscopic specks whether the metal is difficult or easy to ex

In the color print at left, above, red indicates lead in the specimen of copper-lead ore above it

1 For color prospecting, a sample of ore is put into a pressure chamber with a plastic material such as the white powder seen in the photo below

2 At left, Dr. Gutzeit applies heat and pressure to embed the ore in a transparent plastic wafer

3 Result is a specimen wafer about as big around as a nickel and several times as thick, here shown being deposited in the hand by cooling tongs

4 To produce a smooth face for making a contact print, the wafer is polished on a wheel that is delicately balanced on its needle bearings

tract; and how to do it best, as by flotation or leaching. Extracting apparatus can't be bought or installed for pin money, and "color prospecting" may save an operator a costly mistake.

Color prospecting for any given metal takes scarcely longer than describing it. Embedded in transparent plastic, the ore sample gets a light polishing. Then comes the making of a contact print from the specimen, upon a gelatin-coated disk of paper moistened with a solution chosen to remove a trace of the metal being tested for. Now the print goes into an extremely sensitive specific developer, likewise selected for the metal under test. A few minutes—in broad daylight—and a color pattern appears on the paper, corresponding to the metal in the specimen. Typical developers yield a red print for lead, an olive-green hue for copper, and blue shades for iron and manganese. Low-powered photomicrographs of the specimen and color print, magnified exactly to the same scale, may then be superimposed for comparison.

For Dr. Gutzeit's work, the attacking agent, used to prepare the paper, often is a common acid or alkali. But his developers are costly organic chemicals.

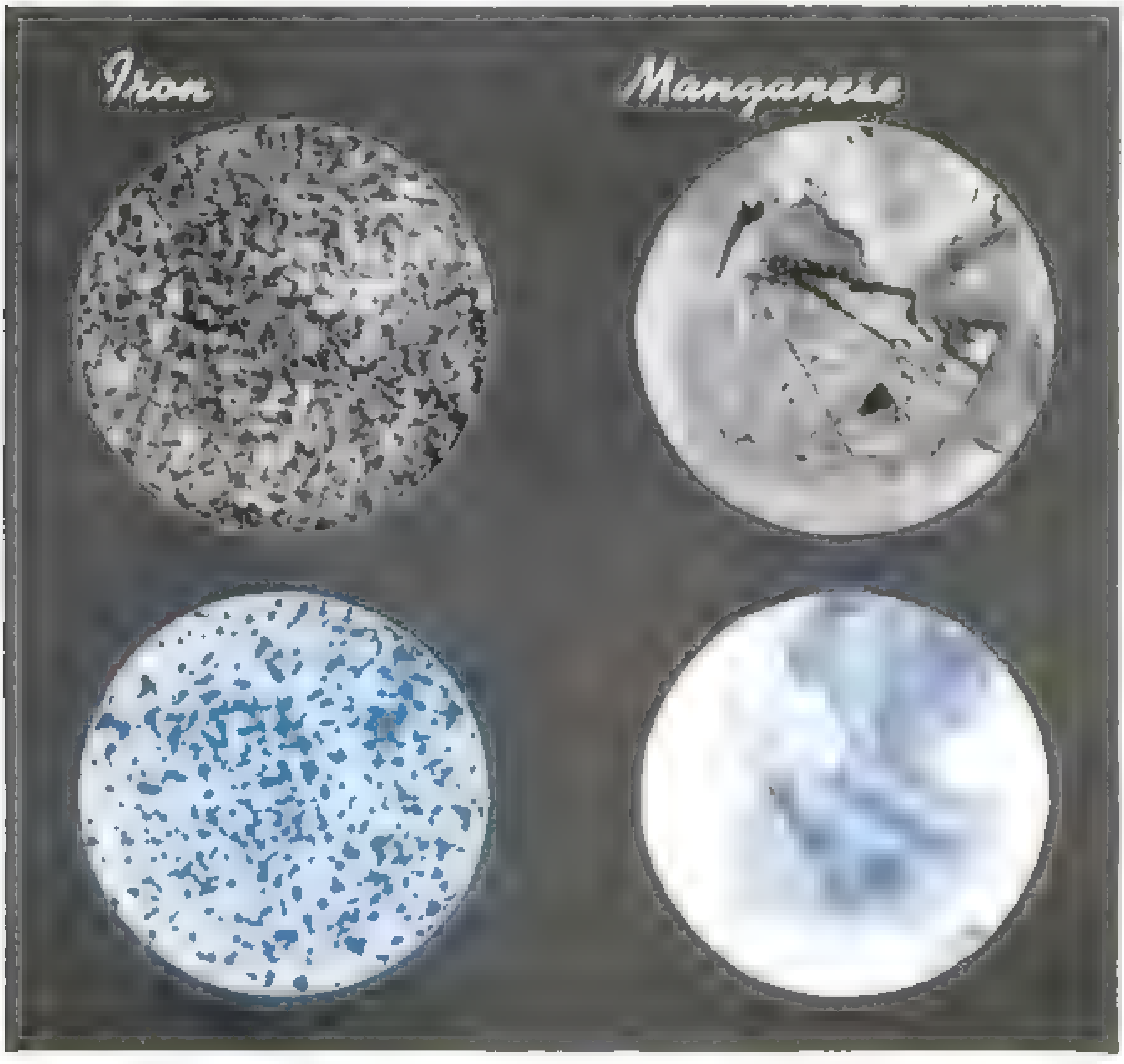
Results? A domestic manganese ore received the color-prospecting test. While it contained considerable manganese, the proportion of pyrolusite and other oxides (shown by dark streaks in the illustration) was low. An attempt to recover the manganese by physical means—say, flotation, or gravity concentration—would certainly have

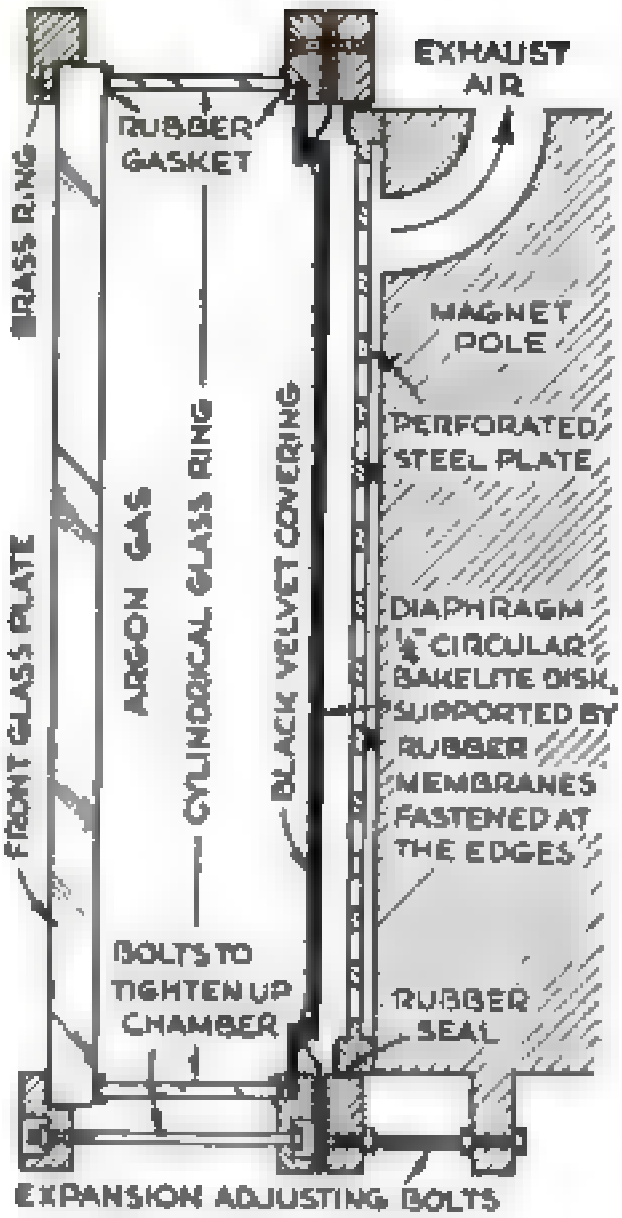
Slag from a copper-smelting furnace seen in the photomicrograph at top, left, contains recoverable copper as revealed by the green pattern in the color print from the same specimen. Similar matched pairs on the opposite page show distribution of iron and manganese in their respective ores, as a guide to their efficient extraction

5 A paper disk moistened with a chemical is put in contact with the polished face and both go into a small press where gentle pressure is applied

6 Developer yields the finished print in color. A photomicrograph of this can be compared with one of the specimens as in the matched pairs

failed. Extraction by leaching—treatment with chemicals—appears more promising. In contrast, the accompanying color print of copper shows that flotation will yield substantial amounts of the war metal from furnace slag and old work tailings of one of the country's largest mines. Interpreted by expert eyes, color prints of other ores likewise tell how to treat rare or complex ores for the essential raw materials of war and peace.





Atomic particles hurtling through the cloud chamber shown at left leave trails of condensed moisture to mark their path, while a huge electromagnet deflects them for weighing. The sectional diagram above shows how the alcohol vapor inside is chilled into droplets

Tracking Cosmic Rays

NEW CLOUD CHAMBER SHOWS PATHS OF ATOM PARTICLES

SHAPED like a musician's drum, a cloud-making chamber of advanced design will help Dr. Carl D. Anderson, noted California Institute of Technology physicist, to observe the flight of fragments of atoms traveling at nearly the speed of light.

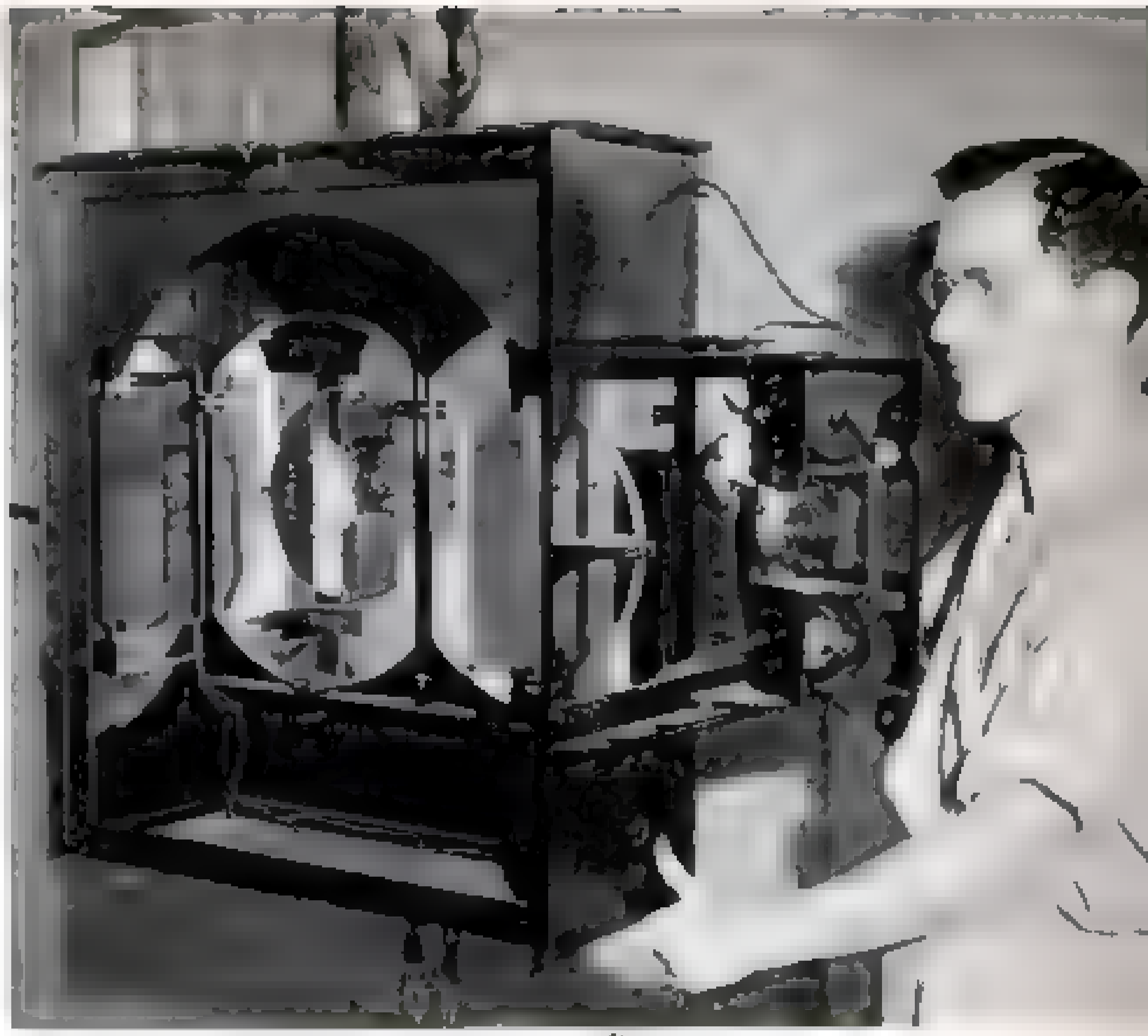
Twenty-four inches in diameter, the instrument doubles the size of former apparatus. A giant electromagnet, in which it is placed, makes it eight times as powerful. And twin cameras, trained on the chamber from different angles, yield stereoscopic photos showing a particle's path in three dimensions.

Hurtling fragments of smashed atoms, such as protons, positrons, and mesotrons, lie beyond the vision of the most powerful microscopes. But much as the smoke trail of a sky-writing plane marks its course, so a trail of condensed moisture reveals the route of a sub-atomic particle through a cloud chamber. A photograph of the curving streak, under microscopic measurement, actually weighs the particle by showing the deviation from a straight line caused by the magnet.

Readying the new cloud chamber for action means filling it with inactive argon gas, to slightly more than atmospheric pressure, and also providing a supersaturated atmosphere of alcohol vapor. The movie-type cameras, set for single-frame exposures, have their shutters open in total darkness. The stage is set.

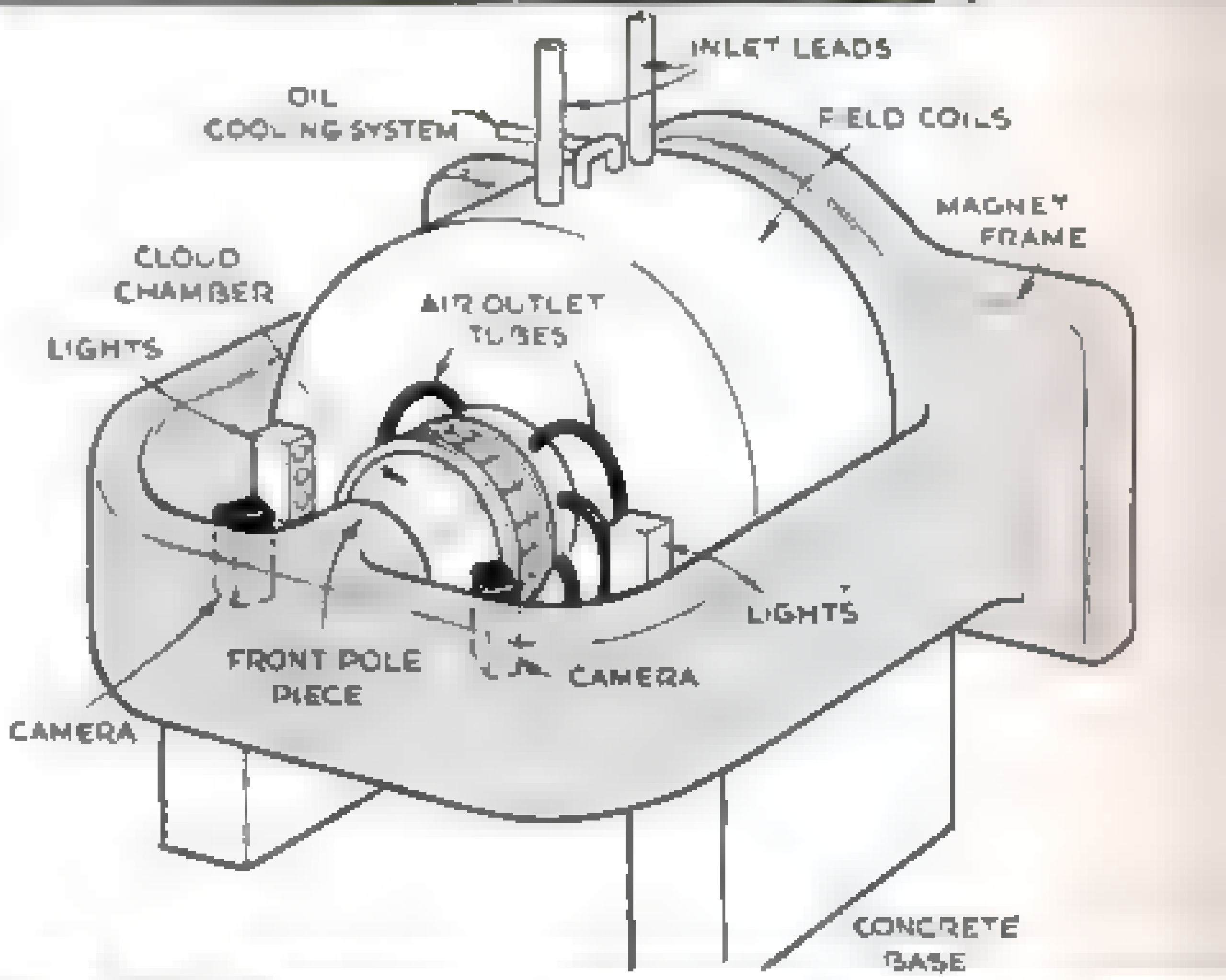
When the awaited particle makes square hits on a pair of electrical targets called Geiger counters, a valve releases air trapped behind the movable back of the cloud chamber, which instantly retracts half an inch. This expands the contents of the sealed chamber 10 percent and chills them 25 degrees F. in a flash. The alcohol vapor con-

When a subatomic particle sets off a pair of Geiger counters, a valve at left, above, goes into action to reduce the pressure in the cloud chamber by exhausting the air from behind the diaphragm. Two cameras, at right, fitted with mirrors to increase their focal distance, take stereoscopic views of the paths of "smoke" left by the atom fragments



denses. Momentarily it forms a two-foot "string of beads" by collecting in droplets on argon atoms ionized by the passage of the particle. Blue light, from a pair of ultraspeed argon lamps, floods the chamber for 1/100,000 of a second while the cameras record the fleeting scene.

One of the first applications of the superpower cloud chamber will be to bare the secrets of cosmic rays, mysterious radiations that bombard us from outer space. Those that reach the earth's surface, mostly produced in the upper atmosphere, consist chiefly of mesotrons—a recent addition to the known varieties of atom-core wreckage. Every man, all his life, has been exposed to them. What do they do to us? If ways could be found to produce and control them, could they work such medical wonders, say, as X-ray tubes, radium, and cyclotrons? The first step must be to learn the basic physical facts about them, and the superpower cloud chamber has been designed to do just that.



Paths of high-energy electrons, two positive and two negative, as photographed in a cloud chamber. Drawing above shows how the apparatus is mounted between the two poles of the giant horizontal electromagnet

Row of new foamed-slag houses for bombed-out Coventry in England where the war has made timber scarce

Foamed-Slag Homes Save Lumber

Home-Rebuilding Project in England's Coventry Uses Blast-Furnace Waste

This is a typical English parlor in ivory, gray, pastel yellow, and brown for one of the homes at top. Each house has three rooms downstairs . . .

. . . and three upstairs. Below is one of the cozy bedrooms lighted with a broad window. Its warm colors are similar to those in the parlor

NEW homes using "foamed slag" as a building material are rising from the ashes of old ones at Coventry, England, razed by German bombers about a year ago.

Seemingly inexhaustible piles of slag from blast furnaces in the steel centers of the country furnished the inspiration. The "foamed" product is a lightweight, cellular aggregate, free of sulphur and other impurities, which is obtained by rapidly cooling suitable blast-furnace slag. A mixture of the dark gray, granulated material with cement is said to be stronger than concrete made with natural stone, lighter in weight, and fireproof and soundproof. By combining layers of foamed slag with precast sections of reinforced concrete, floors, beams, and joists of great structural strength may be easily fabricated. In addition to being cheap and plentiful, the material has a further advantage in that nails can be driven into it.

Behind the adoption of the new

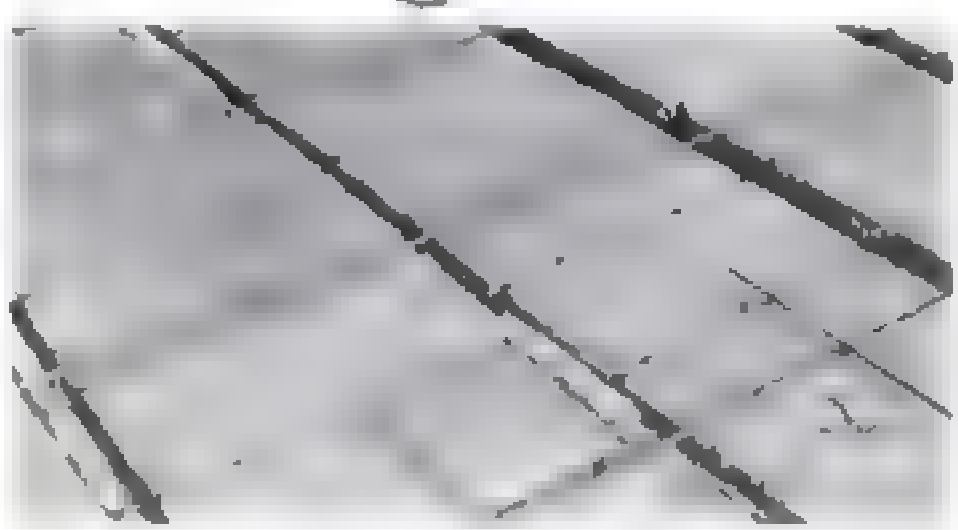
Prefabricated foamed-slag beams laid on supports and ready for a subflooring made of foamed-slag slabs

structural material lies, in large part, the fact that Great Britain has been faced with a shortage of timber since the beginning of the war. Her ships and our own have been engaged in the more pressing need of transporting food and munitions. Out of sheer necessity, therefore, has arisen a way of making the nation's building industry virtually independent of outside sources of timber. Architects are so pleased with the first result—250 buildings erected in a large-scale housing development—that they are wondering why they didn't try this scheme before.

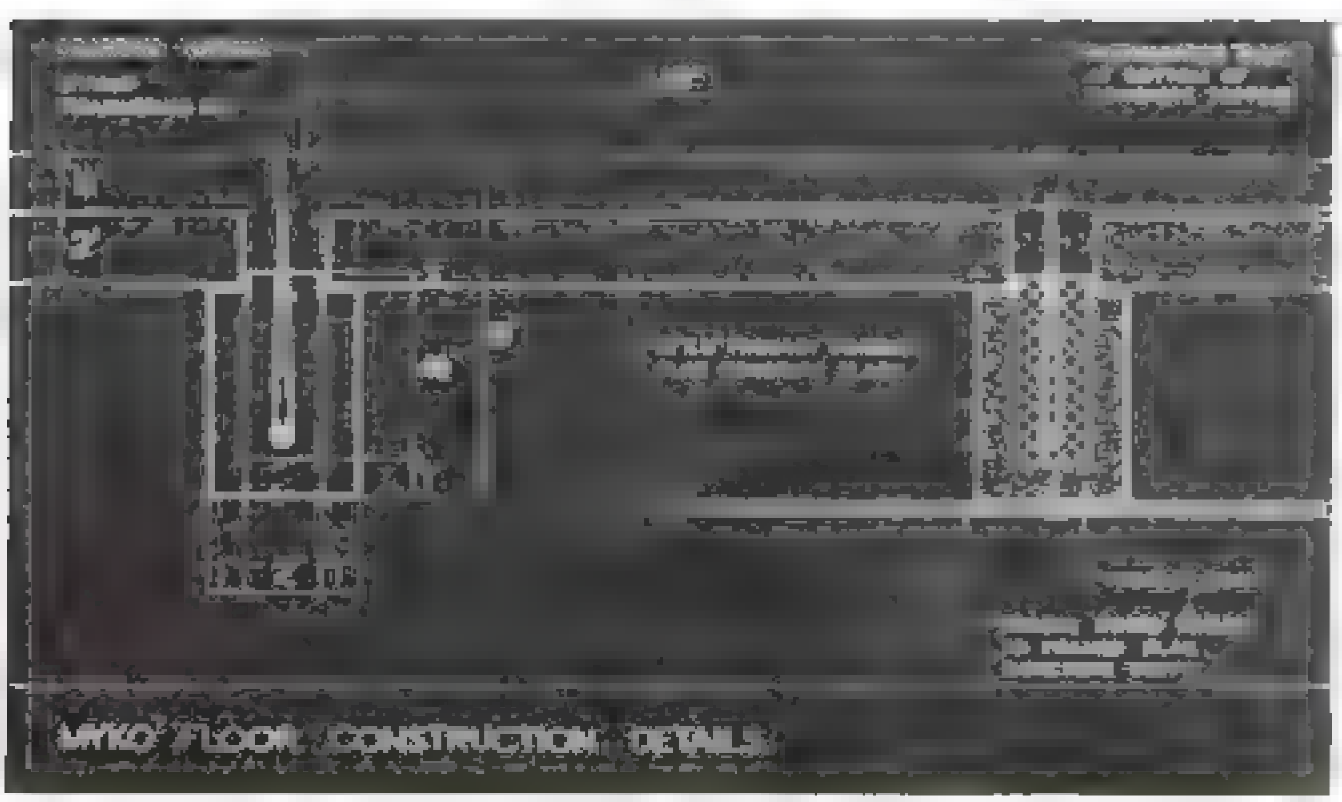
How little the change affects the exterior appearance of the building or the interior of its cozy rooms may be seen in the three views on the facing page, while on this page are shown materials and methods of assembly.

As insurance for the future, each house has an interior bomb shelter entered from the kitchen.

This standard stair unit is precast also of the foamed slag used in the building



Here slabs of concrete mixed with a base of foamed slag are laid on the floor joists. They will receive a topping of reinforced concrete as a finish



At left, cross section of the construction. This type of building is strong, fireproof, and dry, won't shrink, and cannot be affected by termites or dry rot

Built largely of wood, the Boeing AT-15 crew trainer is the first plane to be specially designed and equipped for integrated training of bomber crews

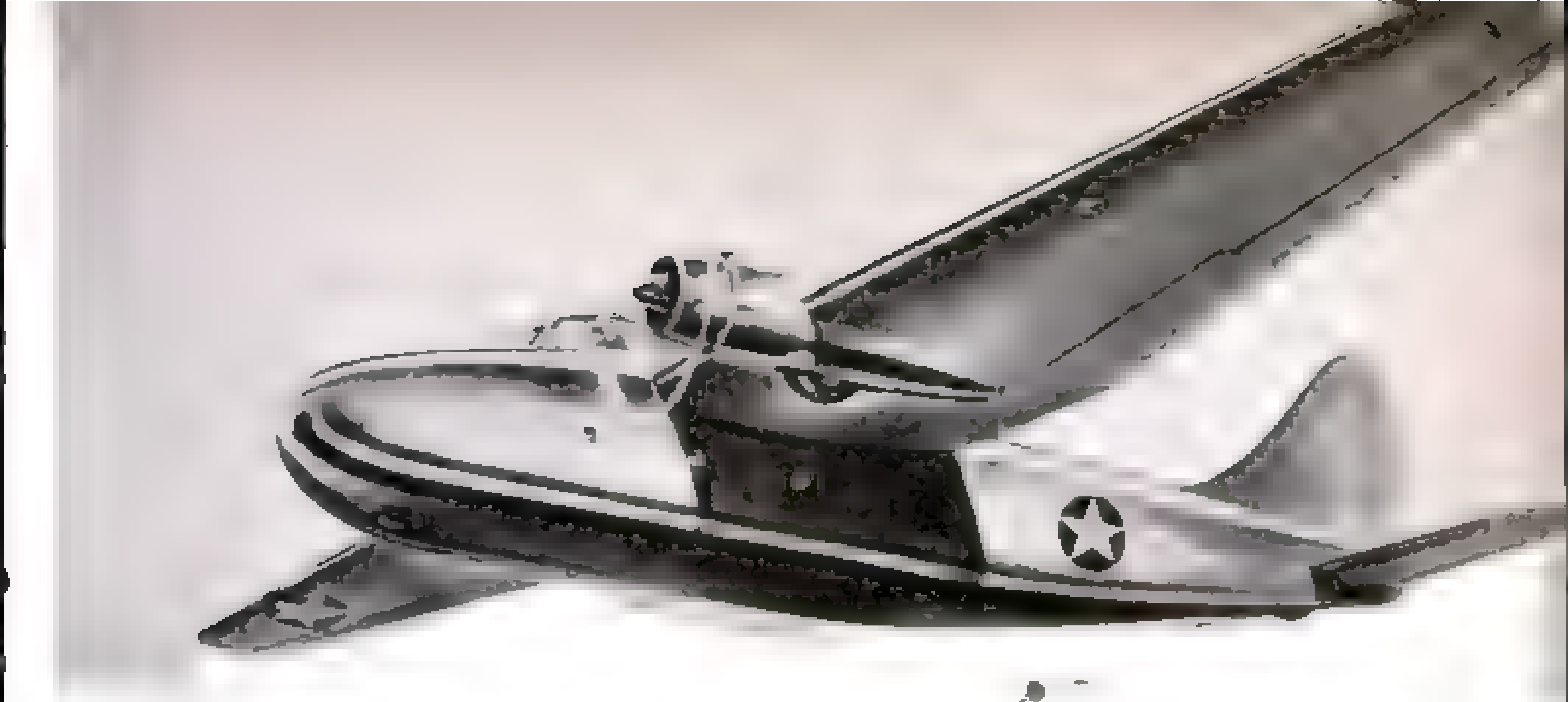
Wood is a War Weapon

IN CARGO PLANES, TRAINERS, AND GLIDERS PLASTIC PLYWOOD REPLACES NEEDED METALS

IT WOULD be a serious mistake to assume that wood as a structural material is making its comeback by default, simply because metal is unobtainable. Priorities afforded the opportunity, but wood was ready to climb back into the ring because wood technologists had been giving it some intensive training during its period of partial eclipse. In some fields metal will always remain the champion; it is inherently better. In others wood has never relinquished its equally inherent advantages. In between there is a zone in which wood can give the metals a run for their money—*if* it is as scientifically prepared and fabricated as the metals have been.

The details are shrouded in military secrecy, but the Curtiss-Wright Corporation announces that it will shortly begin production on a two-engine Army cargo plane about as big as the familiar DC-3 commercial transport, but built largely of wood and other "non strategic" materials. Our minds go back to Eddie Rickenbacker's "flying coffins" of World War I, and misgivings arise. We need not worry. The wood in those new Curtiss C-76's will be as different from the wood in the DH-4's as the designs and engines are different. The indications are that it will do the job just as safely as metal, and leave a considerable tonnage of aluminum for the pursuits and bombers, where it is vitally needed.

Wood is being used increasingly for certain parts of pursuit and bombing planes, not to speak of trainers. One trainer even has wooden fuel tanks. Gliders, which may be expected to assume increasing importance in air transport, are made largely of wood. Wood is being used not only in the air, but in such diverse applications as tank interiors, arsenal shell holders, Signal Corps trailers, Army cantonments, airplane hangars, factory buildings, speed boats, etc. The torpedo boats which carried MacArthur on the first lap of his trip from Bataan, and



The new Curtiss C-76 cargo plane, about as big as a DC-3 transport, also uses "non-strategic materials"

those used by Lieut. John D. Bulkley in his attacks on Japanese naval shipping, were of wooden construction. No less than 300,000 board feet of lumber are used in building a steel battleship.

But modern wars are not won solely by heroes and the equipment with which they fight. We are told that 16 or 18 men in industry stand back of every man on the firing line. They don't just stand, they work in buildings. And here wood comes into the picture as a construction material only less important than steel and concrete. Construction engineers, who for the past century and a half have tended to be almost exclusively metal-minded, have to a considerable extent returned to thinking in terms of wood. They have found that wood, properly used, can serve many construction purposes as well as steel. Wood girders can be built up of 2-by-4 or 2-by-6 planks, fastened together with nails, bolts, or glue, or combinations of these. The RCA Manufacturing Company recently built a warehouse with 125,000 square feet of floor space in which the roof is supported by 198 timber girders assembled on the site. Another job of the same general type, involving roof trusses with a 100-foot span, was done for the Lincoln Aeronautical Institute at Lincoln, Neb. In this case the trusses are curved chords or arches built up in layers or laminations of 2-by-4 fir, glued face to face with casein glue. Another casein-glued, laminated-timber arch construction is that of the Lexington, Ky., school of the Signal Corps. Here it was desired to eliminate all metal above the ground floor in order to facilitate tests of sensitive instruments, and even the splice plates of the arches were made of wood instead of steel. An example of a large factory constructed of wood is the

Wanted: Woodworkers and Engineers to Build Plywood Gliders

SKILLED furniture makers, cabinetworkers, and plywood craftsmen are urgently needed to help train workers who will build plywood gliders for America's air armadas. Graduate engineers also are required, to compute stresses between structural members. Our Army needs thousands of huge transport gliders. At plants like the Snead glider factory in Orange, Virginia, farm boys will learn this special wood craft in a few weeks from experienced men who themselves can quickly become leaders and foremen. An example of the work is seen in the photograph at the right, showing a hull-frame assembly.

Wright Aeronautical Corporation's new plant at Paterson, N. J., which was completed in 45 days with a saving of at least two months over an equivalent plant of steel or masonry

Wood, treated with creosote or with more recently evolved preservatives like chromated zinc chloride (CZC), is claimed to be more than a substitute for metal. It is essentially a new building material. This has a bearing on home construction. Timber is still used in three quarters of our residential housing construction. But it is as much misused as used. The U. S. Forest Service estimates that of the 14,000 board feet which go into the average home, 20 percent—the first floor joists, studding, and subflooring—should be treated against decay and termite destruction. The cost of such treatment is about $25 per 1,000 board feet, or less than $75 for the whole house—about 1 percent of the total cost—and it may save the owner $200 on termite extermination in a few years.

Important as the advances of recent years in the preservation and utilization of solid timber have been, the most striking developments in wood technology have taken place in the field of plywood. Wood, whether in a living tree or in the form of lumber, absorbs moisture, swells and warps across the grain, splits along the grain when subjected to enough force. But these weaknesses are curable. Instead of sawing a log into boards, it may be "peeled" in a giant lathe—rotated about its axis and sliced into a ribbon of veneer a tenth to a seventh of an inch thick, like unwinding paper from a roll. Pieces of the ribbon, or plies, may then be glued together to form a slab. The grain of alternate layers runs at right angles; thus each layer counteracts the tendency of the adjacent ply to warp or split, and the resulting product retains the good qualities of wood while practically getting rid of its weaknesses.

Almost everyone has heard of the so-called plastic airplane, and a good many people have been led to believe that before long planes would be pressed out like cup cakes, complete from nose to tail. The only trouble with this expectation is that there is no such thing as a plastic airplane, and no present indication that there ever will be one. What there is—and it is very real and very important—is an airplane of plywood bonded with plastic adhesive. And, equally significant, plywood parts of metal planes.

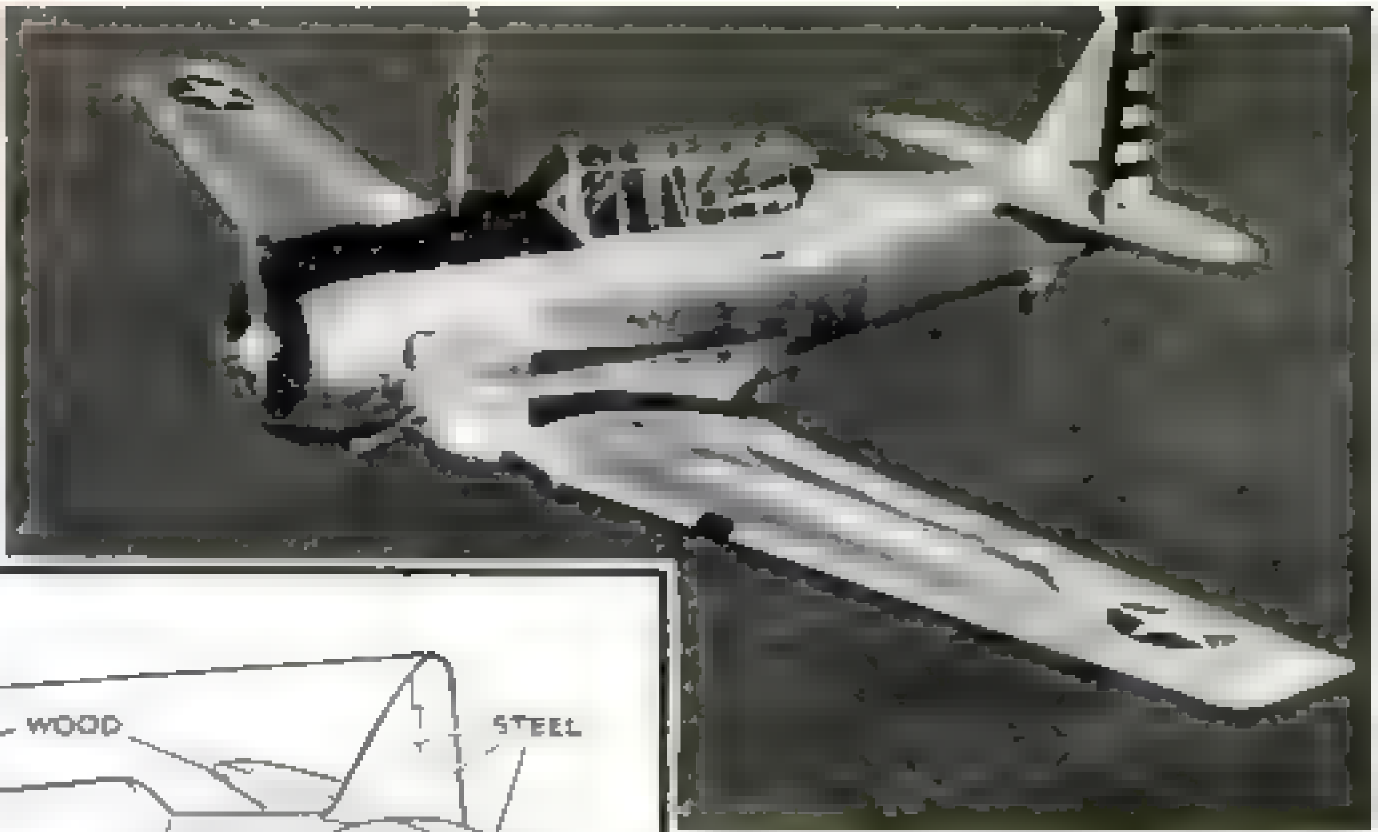
Modern plywood is the offspring of the marriage of resin or plastic adhesives and wood, and combines the good qualities of both. The marriage was the result of processing based on careful research. The wood technicians did substantially the same thing with resin and wood that the metallurgists had been doing with alloys—making combinations which were stronger and better adapted for specific purposes than any of the constituents alone.

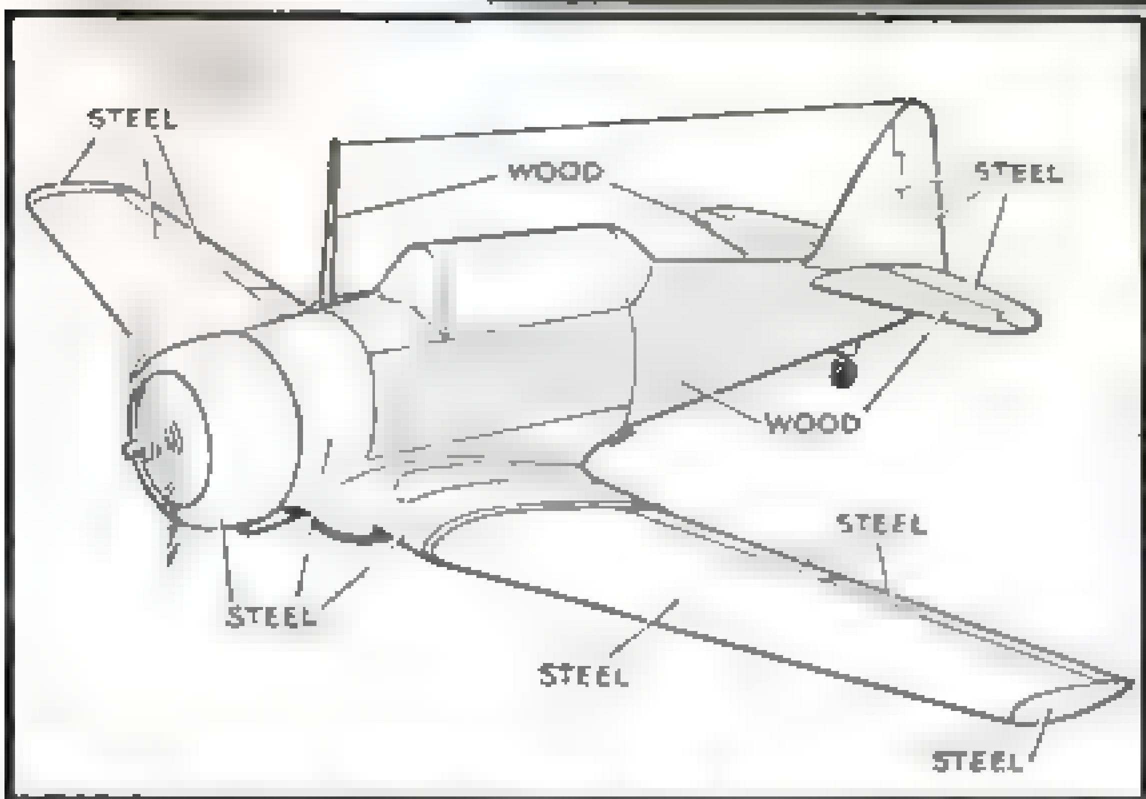
The resins, which form the basis of modern plastic-and-plywood technology, cover a wide chemical range, but all of them contain carbon, hydrogen, and oxygen. Some are natural and some are synthetic. Examples of natural resins are amber, turpentine and rosin, lac (used in sealing wax, shellac, etc.), sandarac, etc. Such resins are secreted by certain plants and insects. A typical synthetic resin, or resinoid, is bakelite, made chemically from phenol (carbolic acid) and formaldehyde. Synthetic resins are generally made by polymerization or chain-linking of molecules, like synthetic rubbers. What we call plastics nowadays are synthetic resins combined with fillers like sawdust, paper, or cloth and molded into panels and other shapes. These resins also yield adhesives for bonding layers of wood to form plywood, or for impregnating and bonding wood under appropriate conditions of heat and pressure.

Wood and resins have a natural industrial affinity in that wood usually has higher tensile than compressive strength—it resists stretching better than it resists crushing—whereas the resins, when set or solidified, have the opposite strength characteristics. In this way resins have come to the help of wood by adding to its compressive strength, or, looking at it from the alternative standpoint, wood can reinforce the resins by adding to their tensile strength. In either case the product, applied to aircraft, for example, provides a stronger material for wings, fuselages, and other parts than wood or plastics alone.

It is not only a stronger material, but a more durable one. Lack of durability was one of the principal faults of the wooden airplanes of World War I. The weakness was in the bonding rather than in the wood itself. The best adhesives then available were albumin, a dried animal-blood product; starch glue made from tapioca; and casein. As we have seen, casein glue is very suitable for bonding structural timbers which, once they are in position, are protected from the weather, but in an airplane wing it is subject to alternate wetting and drying which in time may weaken it and even cause separation of the laminations. Moreover, airplanes are attacked not only by human enemies, but by parasitic growths, and albumin, starch, and casein succumb readily to molds, fungi, and various common types of bacteria under unfavorable climatic conditions. It is said that some of the Fokker planes used in the Dutch East Indies grew

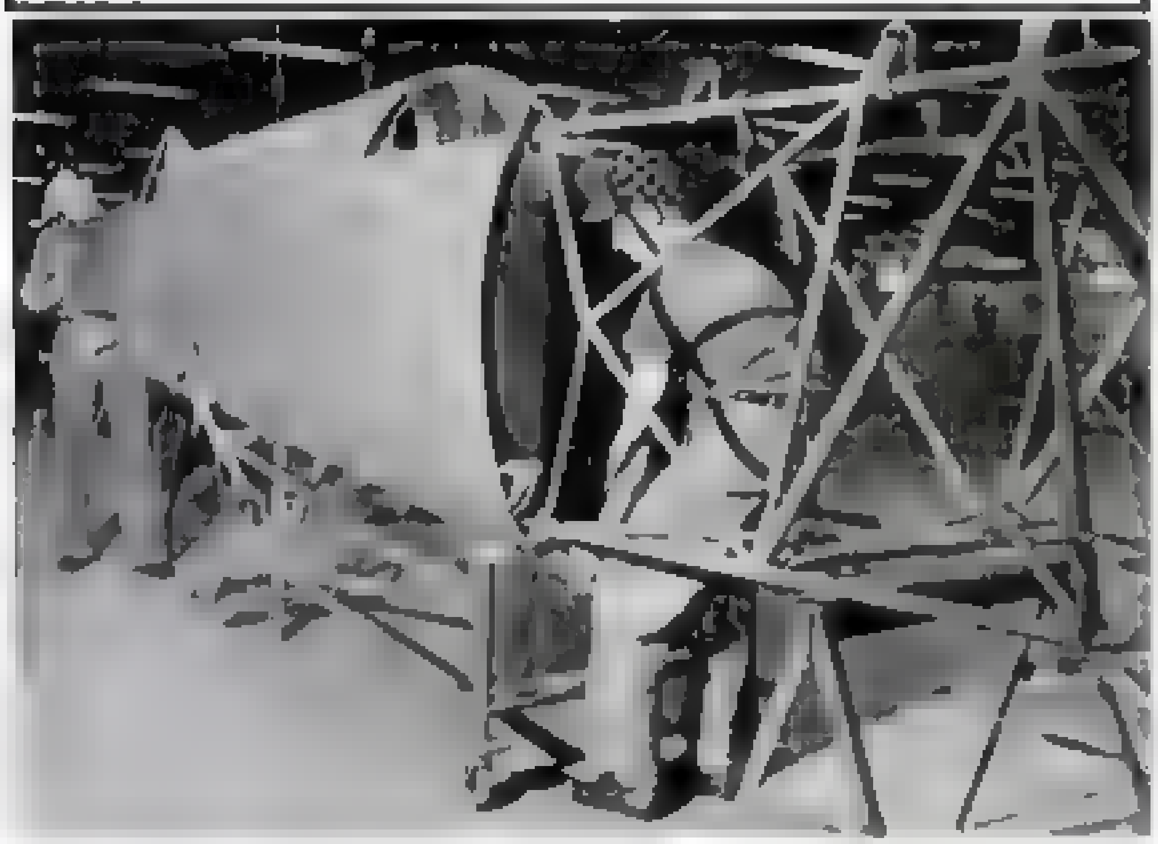
Mahogany plywood replaces metal in the rear fuselage section of the North American AT-6A trainer. Drawing below shows how wood and metal are combined in it



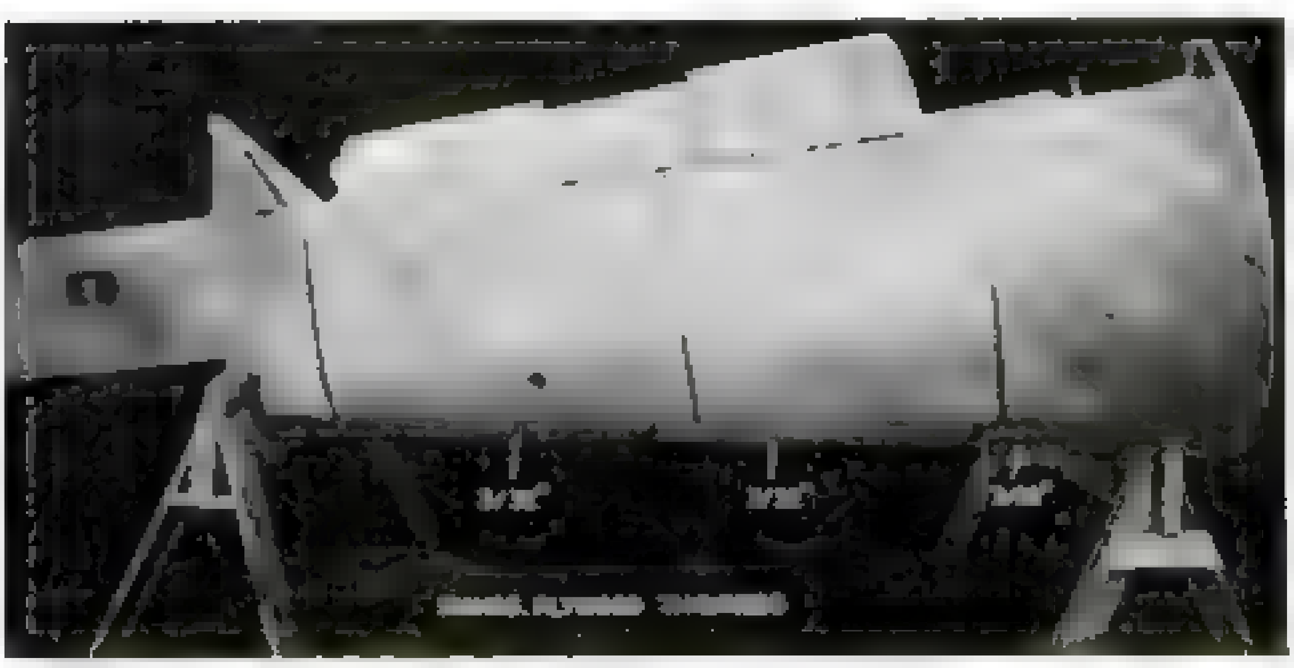


mushrooms inside the wings. These were among the reasons for the replacement of wood by metal in airplane construction after the First World War

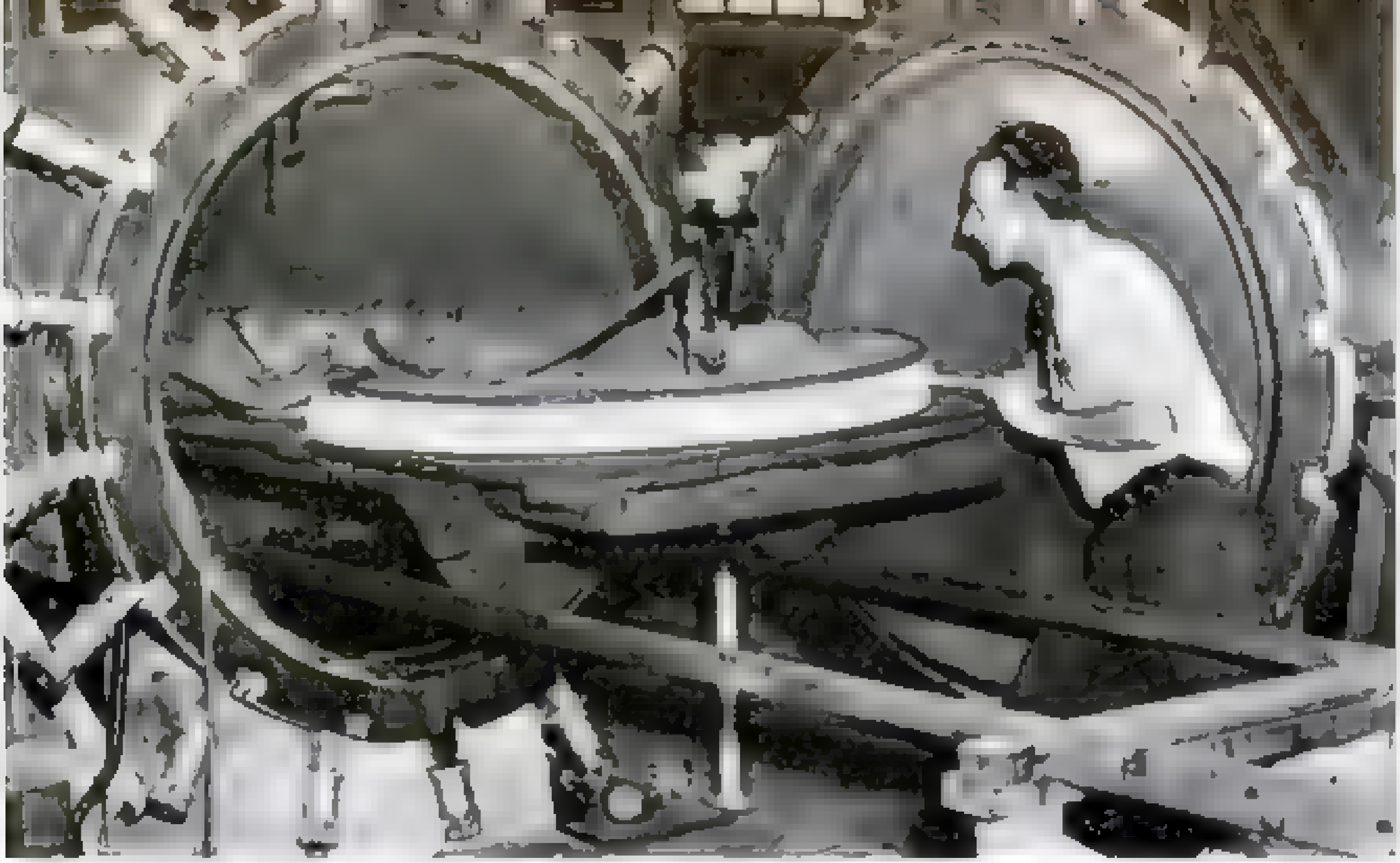
There is not much nourishment for bacteria in a bakelite panel, however, nor in an adhesive made from the same materials. In the 1930's, as the plastic industry developed, phenolic-resin adhesives became available and began to attract the attention of the aircraft industry. Later urea-formaldehyde compounds were evolved and proved superior for certain types of bonding, as in assembly operations. These bonding materials came in the form of films, liquids, and powders. Once the right bonding materials were available, techniques were developed for making plywood under the best conditions of heat and pressure, regulated with far more precision than had been considered necessary with the older glues. It was found, for example, that under pressures

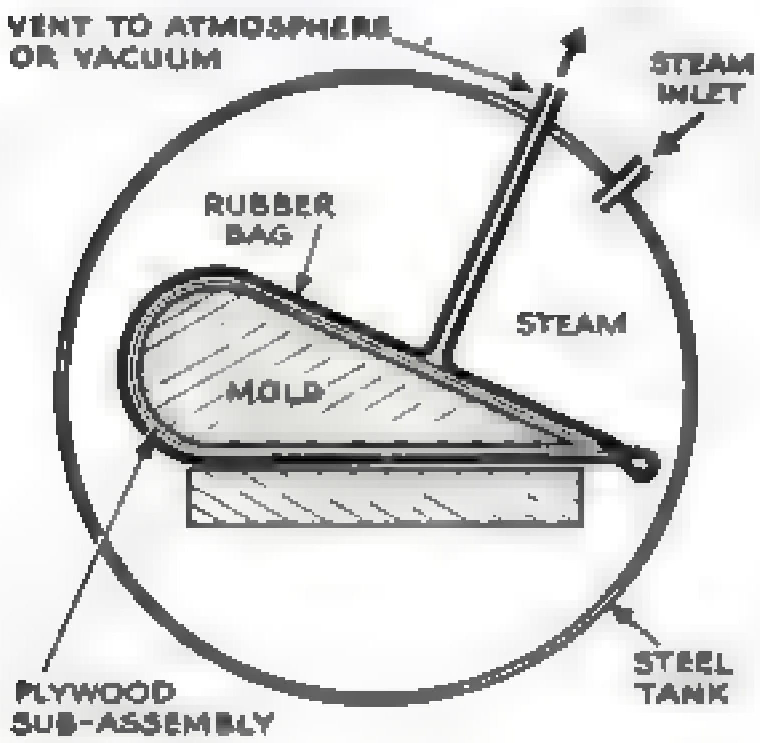


Here the wooden rear fuselage section is being joined to the tubular-steel front fuselage section. It takes the place of aluminum alloy



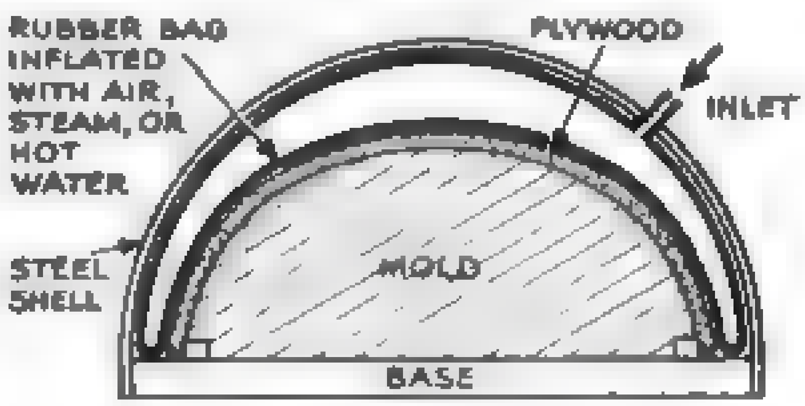
This photograph shows thickness of the mahogany plywood in the various parts of the rear fuselage section. They are molded separately





BAG MOLDING. In the Vidal process, plywood and mold are placed in a rubber bag and vacuum is produced for molding as in drawing at left. Above, bag and mold go into an oven to cure the plastic

ANOTHER METHOD of shaping fuselage members uses a rubber bag to press the plywood over the heated mold, as illustrated in the drawing below



of the order of 1,000 pounds per square inch, high-density plywoods of great strength could be turned out. Another technique along these lines is to impregnate the wood with liquid resin before bonding under compression—hence the term compregnation (compression plus impregnation). The products of these types of processing have found many applications in aircraft, at first in small planes for amateur flying, later in military training planes, then in advanced trainers, transports, and cargo ships, and even fighters and bombers.

High-grade plywood, in a plane engineered to take advantage of its favorable characteristics, may prove equal or superior to an equivalent weight of metal. In plane design one never speaks of strength alone, but of strength-weight relationships. Volume for volume, wood is not nearly as strong, particularly across the grain, as aluminum and its alloys. But aluminum, although light as metals go, is still pretty heavy. A cubic foot of cast aluminum weighs 160 pounds, while plywood made from a light wood like spruce runs only a little over 30 pounds per cubic foot.

Consequently, for equal weight, a plywood aircraft part can be about five times as thick as if it were made of aluminum. This imparts rigidity, and does it in the easiest and cheapest way. Instead of building a wing as a skeleton of metal ribs and spars, with the skin stretched tightly over the skeleton to take a part of the stress—which entails riveting or welding the skin in place—a plywood wing can be made in what amounts to a single piece, with a surface as smooth as glass and drag reduced to a minimum. (Howard Hughes' speed-

CLOTH FROM TREES. Giant redwood trees help relieve the shortage of textile materials. Bark stripped from huge logs at the mills is processed into fibers that can be used in making clothing, hats, and blankets—and also for heat insulation

record-breaking plane had wooden wings.) Fuselages and other sections can be constructed on the same principle to produce what is called unitary shell or monocoque construction, where the shell itself provides all the necessary strength and stiffness.

The molding and bonding of airplane parts made of plywood is a relatively new art and some of the later techniques have not been in use long enough to enable even the experts to envision all their possibilities. One such technique is the flexible-bag method of molding. In aircraft manufacture many parts must be made in intricately and exactly curved shapes. Instead of using pairs of dies for this purpose, it is becoming common practice to apply pressure through a rubber bag, which acts hydrostatically,—that is, the pressure at any point is substantially at right angles to the surface, whatever its shape. An accompanying drawing shows a half fuselage of plywood being molded over a metal form, which may be heated from within by hot water or steam. Over the plywood the rubber bag applies uniform pressure over the whole curved surface. This method is used in making plywood hulls for boats as well as airplane structures. In another application the flexible bag is inside a metal mold.

Another interesting and even more recent technical innovation is electrostatic heating of plywood. As we have seen, to make resin adhesives polymerize or set it is often necessary to apply heat. Naturally, it is found desirable to heat the material evenly

Air-raid shelters of heavy timbers afford a comparatively safe haven if bombs bring down the house. This bed-type shelter in a basement is put together with pegs and is easy to construct. If air raids should necessitate extensive building of shelters in the United States, this type of construction would save metal needed for other war purposes, while giving good protection

Prefabricated barracks of plywood may solve war housing problems. The two-man unit shown being assembled and (below) complete, can be used alone or combined with others for more room

throughout the whole structure. When considerable thicknesses are involved the conventional methods tend to heat the outside layers more than the deeper layers. But by making the plywood act as the dielectric between the plates of a condenser to which a high-frequency alternating current is applied from the usual high-voltage transformer, rectifier bank, and oscillator, as in a radio transmitter, it can be heated to any desired temperature, and much more uniformly and quickly than by any other means. The principle of the method was borrowed from the artificial-fever machines used in medical treatment.

Plywood is no panacea for the troubles of the airplane designer. In the design of fast fighters, bombers, and very heavy cargo planes, in which stresses may be extremely high and, in the case of the fighters, parts must be made as small as possible, metal structures are still the obvious answer. But where, as in trainers and cargo planes, below the largest sizes, the stresses are somewhat less and minimum size is not essential, plywood is a mighty useful material, the more so as the output of aluminum cannot keep up with the enormous demand. Molded plywood parts are used in some parts of bombers and fighters in the first rank of our air offensive. As for trainers, particularly the larger types, in the near future wood will be used almost entirely in their construction. Aside from the engines and a few other parts, the amount of metal in these planes will be only a small percentage of the total gross weight.

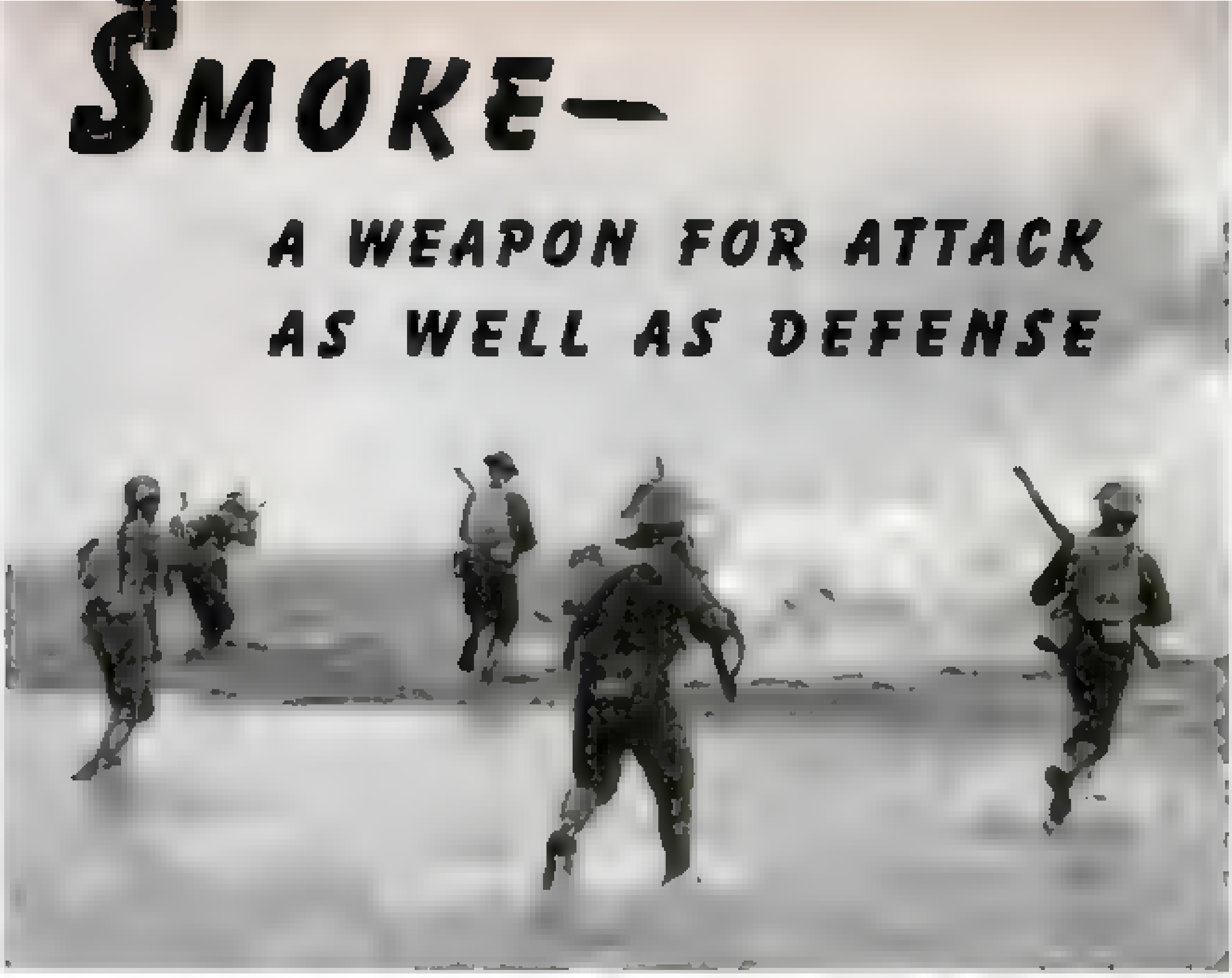
Moreover, it must be remembered that the exterior parts of an airplane, which enable it to fly, are not enough to enable it to fight or carry loads effectively. As a material for floor boards; folding shelves; interior partitions; navigators' tables; bombsight boxes; bomb-bay, bulkhead, landing-gear, and baggage doors; fairing panels; and the like, wood-plastic materials serve the purpose as well as metal, or better. It is reported that in one transport plane a floor of trussed plywood design resulted in a reduction of 120 pounds in weight. It has been estimated (as of January, 1942) that 10,000,000 pounds of aluminum could be saved by substituting wood parts on Government aviation contracts in all suitable places.

The United States is in a far more favorable position than the Axis nations in regard to timber. Before Pearl Harbor, over a period of 15 years Japan was the largest importer of timber from the United States —we supplied her generously with wood as well as scrap iron. We have about four times the amount of standing timber available in greater Germany. Still, we must guard against undue optimism. In wartime all materials necessary in industry are sure to go on the shortage list sooner or later.

But some shortages are more critical than others, and wood can help to relieve the most critical bottlenecks. It has one other great wartime advantage. The major problem facing American industry today is conversion of peacetime plants to wartime production. This problem is always difficult, but it is less difficult in the woodworking industries than in some others.—CARL DREHER.

SMOKE—

A WEAPON FOR ATTACK AS WELL AS DEFENSE



Infantry advancing behind a smoke screen. Used this way, smoke reduces the effectiveness of enemy fire

By ALDEN H. WAITT

Colonel, Chemical Warfare Service

ALL modern armies understand the great value of smoke as an offensive and defensive weapon, and are well acquainted with its hampering effect upon fire power. Screening clouds of varying density, produced from a variety of substances by one or more of three principal methods—spraying chemicals from airplanes, exploding a shell or bomb containing smoke material, or burning a smoke-producing substance—are widely used to conceal troop movements, for other purposes of deception, and to reduce the effectiveness of the enemy's fire by interfering with his observation. This is especially true in tank warfare. British officers of tank units, with actual combat experience in Libya and elsewhere, have assured me that smoke is an absolute necessity for successful tank operations. The machines themselves must be equipped with devices for laying screens, and should also

SMOKE-PRODUCING CHEMICALS AND THEIR PROPERTIES

SYMBOL	NICKNAME	NAME	LOADING	ODOR	TACTICAL CLASS	PHYSIOLOGICAL EFFECT	PROTECTION	TACTICAL USES
HC	*Harmless Cloud*	H.C. MIXTURE		SHARP-ACRID		HARMLESS	NONE	TO SCREEN SMALL OPERATIONS IN OWN LINES AND FOR TRAINING PURPOSES
FS	*Fuming Spray*	SULPHUR TRIOXIDE IN CHLORSULFONIC ACID		BURNING MATCHES		CAUSES PRICKLING OF SKIN, FLOW OF TEARS		AIRPLANE SPRAY FOR SCREEN ON BROAD FRONT
FM	*Floating Mantle*	TITANIUM TETRACHLORIDE		ACRID		HARMLESS	NONE	SCREENING OPERATIONS
DA	*Dopey Ache*	DIPHENYL-CHLORARSINE		SHOE POLISH		CAUSES SICK FEELING AND HEADACHE		HARASSING FIRE
WP	*White Phos.*	WHITE PHOSPHORUS		BURNING MATCHES		BURNING PIECES ADHERE TO SKIN, CLOTHING	NONE AVAILABLE	TO SCREEN ADVANCING TROOPS, CAUSE INCENDIARY EFFECTS, LOSSES, HARASS ENEMY OBSERVERS

Crossed retorts, combined with the familiar six-sided benzene-ring symbol, form the insignia of the Chemical Warfare Service

Smoke pots resembling the smudges used by fruit growers put gray clouds over important military targets

Lighting a smoke pot. Partial burning of oil in a combustion chamber is controlled by adjusting the draft regulator seen below. Dark smoke is better than light for baffling enemy bombers

be supported by special troops carefully trained in the technique of blinding the enemy's artillery and antitank guns by well-placed smoke.

Properly used, smoke is especially valuable in attack. A smoke screen may be employed to protect an advancing unit from fire on a flank, and may make it possible to bring up weapons, to move reserves, to shift positions, and to obtain surprise. In the campaigns in Poland and the Low Countries the Germans frequently used smoke with marked success to cover attacks by pioneer and assault troops upon pillboxes and other strong points. Smoke generally draws fire, and this fact may be utilized to divert the enemy's attention toward unimportant areas. It is extremely effective when placed upon or close to the enemy's observation. Even greater advantage may be gained if the smoke can be placed directly upon his actual defensive position. Under these conditions the attacker can no longer see the enemy, but knows his approximate position. The enemy, however, enveloped in smoke, has lost his bearings and is completely disoriented. He can neither aim his weapons nor observe the effect of his fire.

To show the effect of smoke upon the accuracy of rifle fire the Army's Chemical Warfare School conducted a series of tests which extended over a period of several years. The members of each class that came to the school, comprising Army, Navy, and

How smoke is used in connection with antiaircraft guns, searchlights, and barrage balloons to guard an industrial installation. It distorts light from moon or flares, making the target hard to recognize

Marine Corps officers and enlisted men of all grades, fired from five to ten rounds at silhouette targets under three different sets of conditions. The average number of hits scored, when no smoke was used, was 55 percent. When smoke was placed upon the targets the same firers made an average of 12 percent of hits. But when smoke was placed upon the firers, this average was reduced to three percent. From these tests it is clear that smoke on a defensive position will give an advantage to the attacker of more than four to one in relative fire efficiency.

In defensive situations also, smoke may be useful. It may be used by a defending force to cover changes in disposition, to conceal movements of artillery, to permit the withdrawal of troops exposed to enemy observation and fire, and to retard or hamper the movements of hostile tanks. Not only does a well-placed smoke screen cause the tank to reduce speed, but when it emerges from the screen it presents a perfect target for the antitank gunner as it is outlined against the white background of the smoke. In areas remote from the battlefield, smoke has been found of great value in the defense of factories, oil-tank farms and other installations which are important and legitimate targets for bombing planes. Unless lights are present on the ground, the smoke thus used to supplement air and ground defenses need not be completely obscuring. It is sufficiently effective if it distorts or absorbs enough of the light rays from the moon or the flares dropped by enemy aviators to make the ground features difficult to recognize.

For this purpose dark smoke is better than white smoke, since it absorbs the light and blends with the ground objects. One of the most widely used methods of producing the extensive screens required to protect large industrial or military installations is by the partial burning or distillation of oil in a generator. This apparatus is similar to the orchard smudge pots and heaters used in the fruit groves of California. A metal pot serves as an oil basin and combustion chamber, with a sheet-metal chimney and various devices to regulate the draft. Low-grade fuel oil burned in this generator gives off large quantities of dark-gray smoke. The cloud thus formed may have little value during the day, but at night, as proved by European experience, apparently is very effective. Observed from the air after dark, the screen sometimes has the appearance of a large body of water. It may lead the bombardier entirely astray in calculating the location of his target.

From a technical point of view a screening smoke is a cloud of extremely small solid or liquid particles suspended in the air. The screen accomplishes its purpose by scattering light rays by reflection from the many individual particles, and by actual

obstruction of the rays. Material should be used which will provide many particles divided as finely as possible, because in this form it will remain suspended for a longer time and scattering of the rays is more complete. Also, a given quantity of this type of material will yield a larger number of particles.

Many smoke materials, classified as solid and liquid smokes, are available, and are extensively used by all armies. Typical of the solid smokes is white phosphorus (WP), which is chemically very active and readily combines with the oxygen in the air. A pale-yellow, waxlike solid, white phosphorus melts at about 111 degrees Fahrenheit, and may therefore be loaded into artillery or mortar shells by melting and pouring under hot water. A loaded WP munition contains a small bursting charge of high explosive, so that when detonated the solid phosphorus is scattered into the air in small pieces. The heat generated by the bursting charge immediately ignites these pieces, and clouds of heavy white smoke are formed. This substance is important in chemical warfare not only as a smoke material, but because of the burning effect of phosphorus on personnel and material. Phosphorus burns on the skin are painful and slow to heal.

Another solid smoke, the standard burning-type smoke material of the United States Army, is HC mixture, a combination of zinc powder and hexachlorethane, with the addition of small amounts of two or three other chemicals to control reaction. HC is used in smoke candles, smoke pots, and grenades. Under the influence of heat generated by a fast-burning starter mixture, the zinc and the hexachlorethane combine to produce zinc chloride and free carbon, which pass off as a heavy grayish smoke. The screen thus formed reaches maximum production in about 20 seconds, and the smoke pot, which is a little less than eight inches high and 5½ inches in diameter, continues to burn for approximately 6½ minutes.

The typical liquid smoke, and one of the most important smoke-producing materials, is FS. This is a solution of two acid materials, sulphuric anhydride, which is sulphuric acid with the water removed, and chlorosulphonic acid, which is made by the action of gaseous hydrochloric acid on sulphuric acid. The smoke produced by FS is the result of the combination of its particles with the moisture in the air, forming sulphuric acid and hydrochloric acid. It is used chiefly from airplane spray tanks, but can also be fired in artillery and chemical mortar shells. In the latter, a small bursting charge throws the liquid into the air as a spray when the shell is detonated. The smoke from FS is harmless, although it will cause considerable irritation to the skin and the throat. But the chemical itself is highly corrosive and must be handled carefully. During the First World War FS was used by the Germans in a large metal pot in which the acid in an upper container was allowed to drip upon quicklime in the bottom of the pot. Some such device doubtless was used to produce the blanket of smoke with which the Germans covered the battleships Gneisenau and Scharnhorst when they were in the harbor at Brest and subjected to almost daily bombing attacks by the R.A.F.

Several different devices have been developed by the various armies for producing smoke from tanks and other vehicles. The simplest is the exhaust smoke producer, a simple apparatus which enables the driver to inject crude oil or a chemical into the exhaust manifold. All armies have made use of this idea. The great heat in the manifold vaporizes the smoke material, causing it to pour from the exhaust in a heavy cloud. The purpose is to produce a large puff of smoke behind which the tank, for example, may gain protection for a few moments if it runs into antitank gunfire or otherwise gets into trouble. It would not ordinarily be used to lay a continuous screen, for by doing so the vehicle using it would only outline its path for the hostile gunner.

Another device is a small smoke mortar or grenade thrower, with which the smoke is thrown a few hundred yards away from the tank in the direction of the source of danger. The smoke itself cannot become an aiming point, as may be the case when the exhaust-type smoke is used. At least two different smoke mortars of this type have been used successfully in the present war. One is a muzzle-loading device fastened to the outside of a tank. It will throw a smoke grenade a distance of 200 or 300 yards, but has the disadvantage that in order to fire it a man has to reach outside the tank and drop the grenade down the muzzle. The other device is a breech-loading two-inch mortar, which fires a small smoke munition for distances up to 700 or 800 yards. It may be fired from inside the vehicle, the muzzle being pointed out through a port. Some such weapon is important for emergency use by armored vehicles. It cannot produce a large smoke screen, but it can develop sufficient smoke for getaway purposes. Some tanks also may carry a large mortar for laying screens.

Diamonds are recovered from a concentrate at the lower end of the sluice in Arkansas' hydraulic mining

Arkansas Rediscovers Diamonds

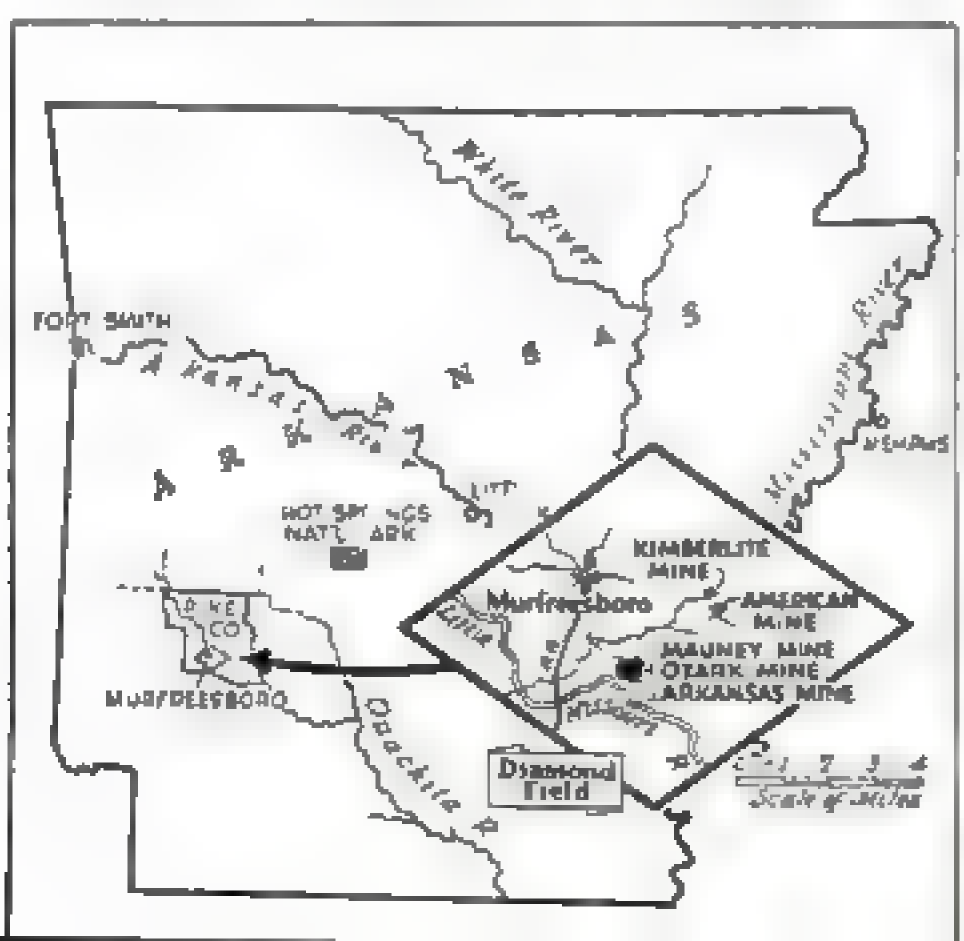
DIAMOND mining in the United States, long dormant, faces a boom. To harvest a crop of industrial diamonds for such war tools as wire-drawing dies and grinding wheels, a St. Louis, Mo., firm has leased an Arkansas diamond mine and plans to spend $1,000,000 developing it. Past records indicate that the undertaking should also unearth some big diamonds of gem quality.

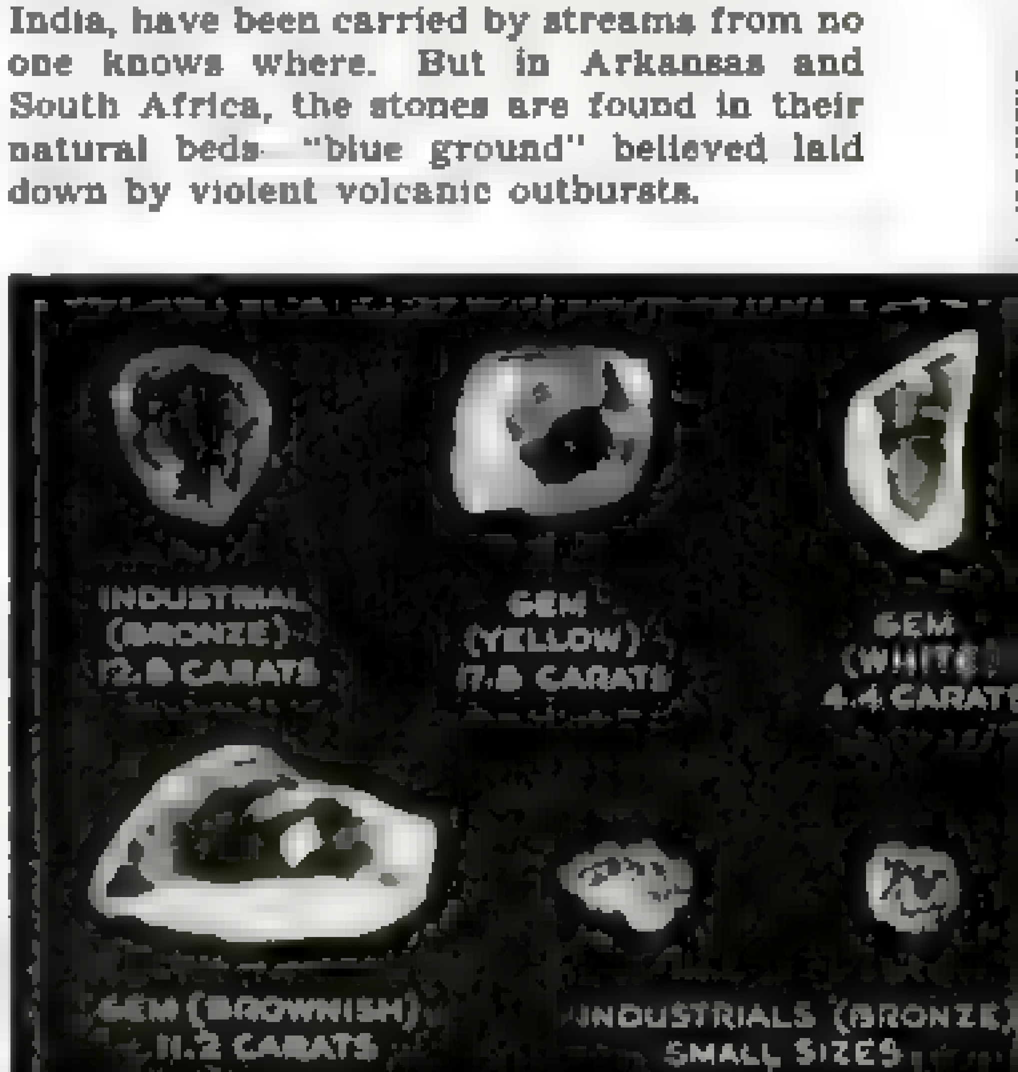
Though miners have hardly scraped the surface of the 53-acre field near Murfreesboro, Ark., they have taken out at least 10,000 diamonds. Some stones are so small that it would take 250 to weigh a carat. Spectacular finds have weighed 17.8 carats, 20.2 carats, and, biggest of all, 40.2 carats. Gem experts call many of them as fine in color and as flawless as the world's best.

Arkansas diamonds include white, yellow, and brown stones. Diamonds with a blue or pink tinge have been found. Bronze-colored stones are used for industrial purposes.

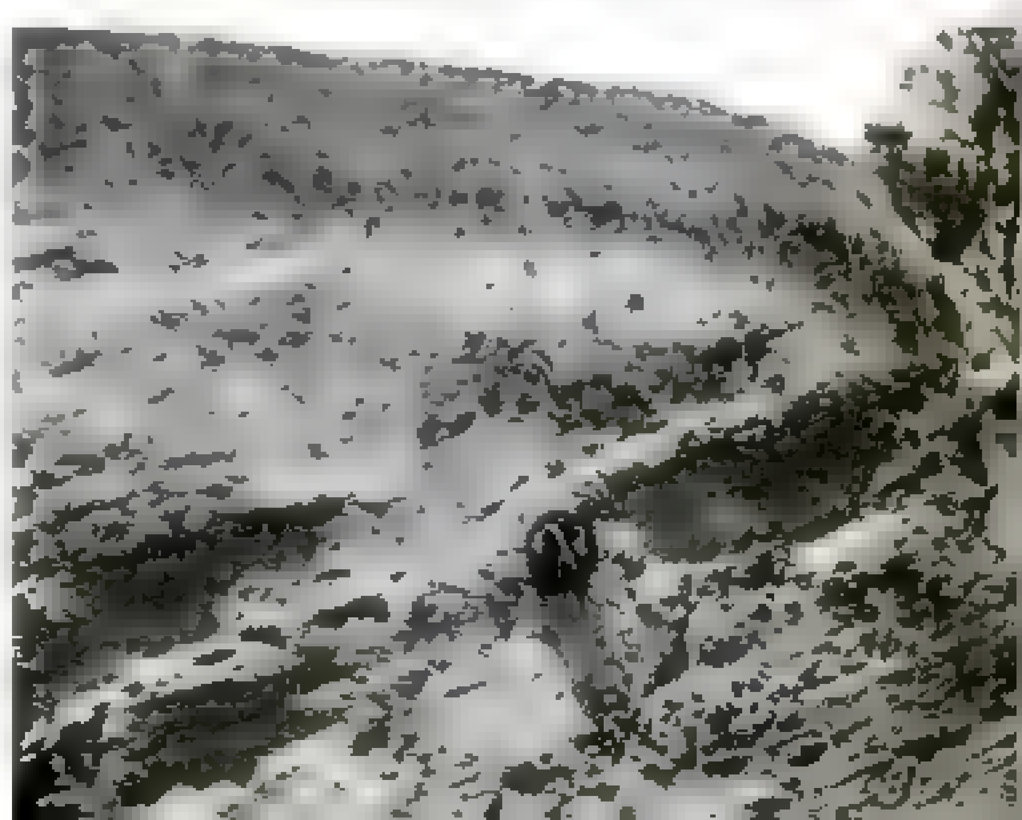
Diamonds discovered elsewhere in the United States, and in Brazil, Australia, and India, have been carried by streams from no one knows where. But in Arkansas and South Africa, the stones are found in their natural beds—"blue ground" believed laid down by violent volcanic outbursts.

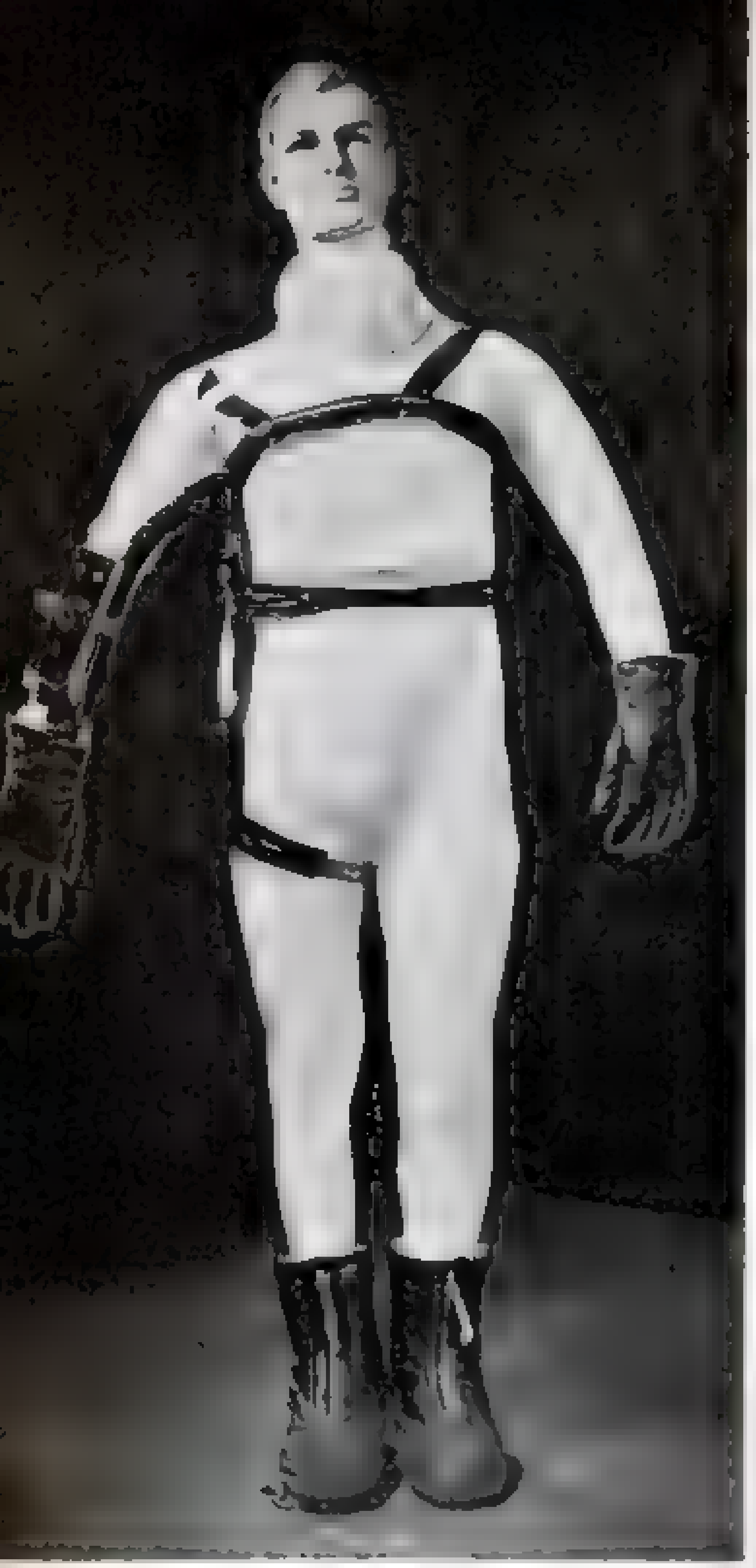
Location of the diamond field in Pike County with an inset showing a close-up of deposits that have yielded diamonds. The map and photos of diamond workings are from the U. S. Geological Survey





U. S. National Museum specimens of industrial and gem diamonds found in Arkansas. A "blue-ground" outcrop, below, duplicating beds in South Africa



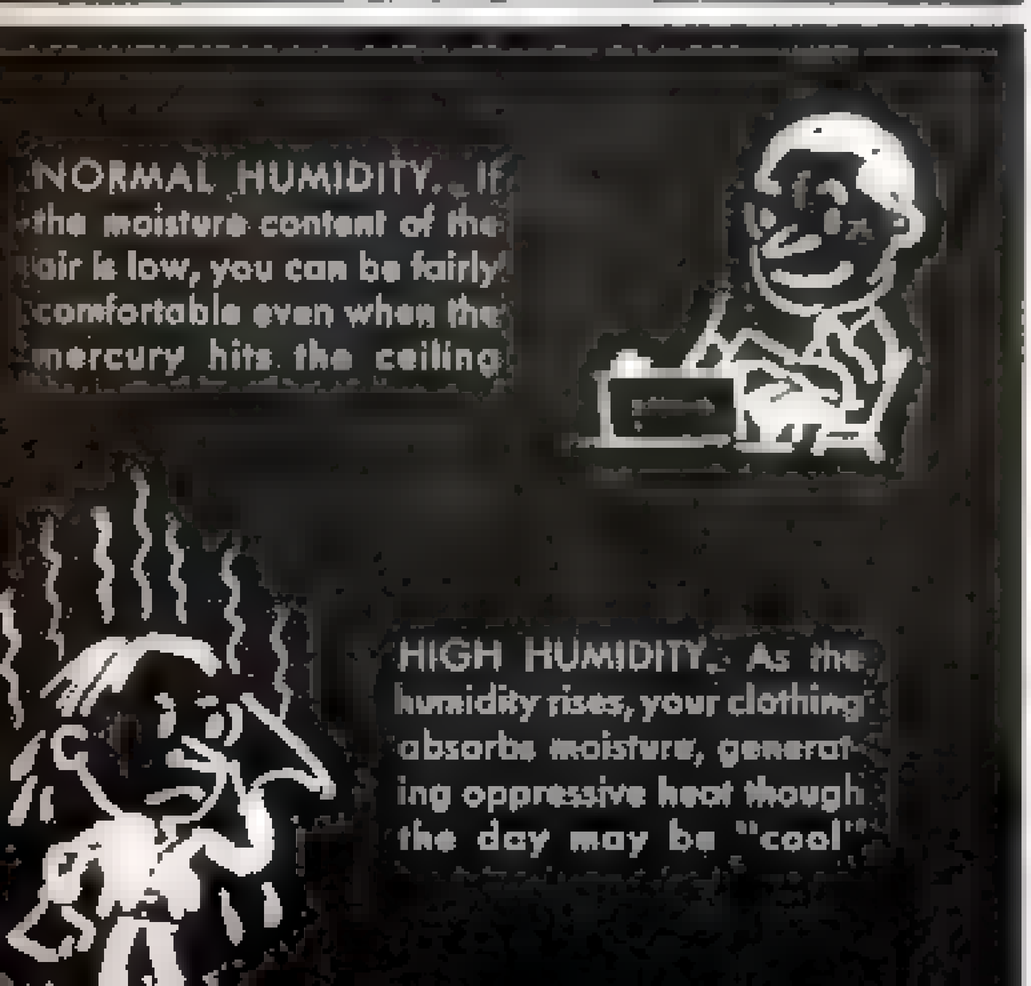


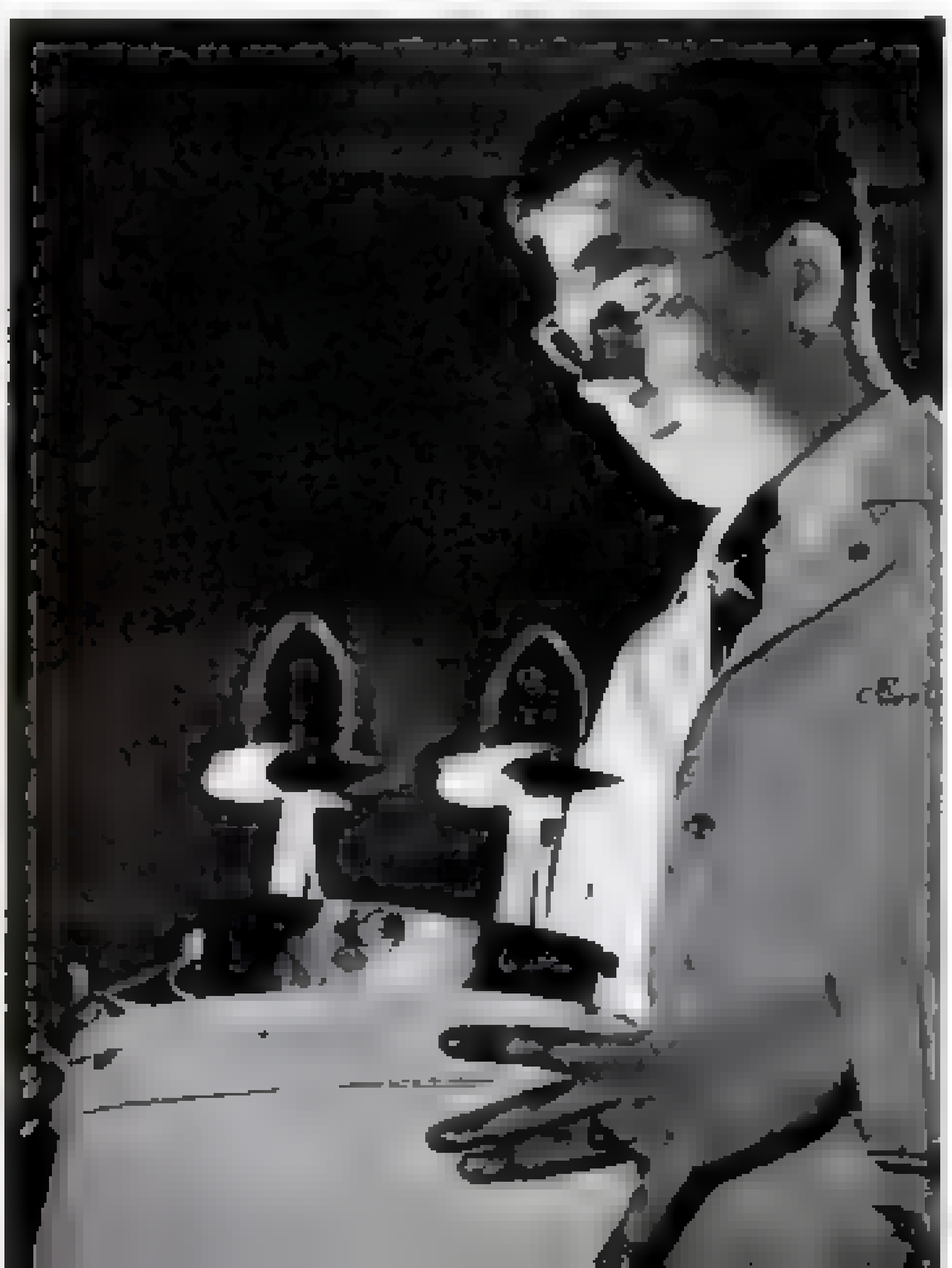
It's the

. . . TESTS SHOW

THE scientists have exploded a good many cherished delusions, but sometimes, when they get through weighing, measuring, and analyzing, they find not only that a popular belief is true, but that it is even truer than anyone suspected. That old saw, "It isn't the heat, it's the humidity," voiced by everyone from the office boy to the president of the company on a muggy summer day, is in this category. When the temperature is high and the moisture content of the air goes up at the same time, people suffer because the body's temperature-regulating mechanism operates at a maximum disadvantage. And now the scientists have found out something which the office boy and the president, and they themselves, did not suspect until very recently—that clothing, picking up moisture on a humid day, may generate surprising amounts of heat. When, for example,

"Oscar," the thermodynamic robot that helps scientists at the John B. Pierce Laboratory study heat interchanges affecting the human body. He wears a harness of thermocouples and his body heat comes from a battery of electric bulbs being lowered into his torso below





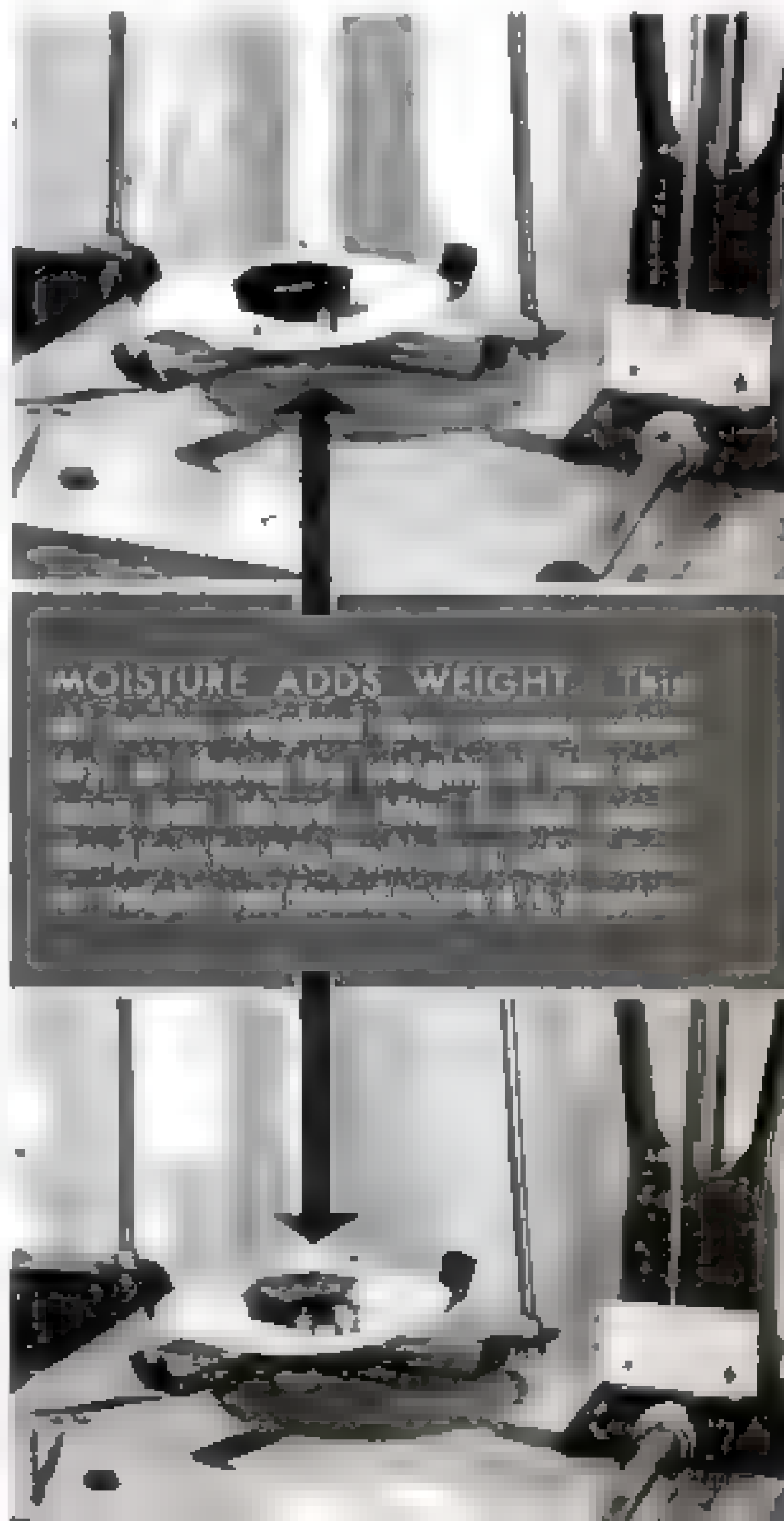
Humidity All Right!

CLOTHING GENERATES HEAT IN DAMP WEATHER

the humidity goes up from 30 to 80 percent, a heavy woolen overcoat will become several ounces heavier and as much as 10 degrees warmer. Under the same conditions an ordinary business suit will exhibit similar thermal effects, and although in this case the absorption of moisture and rise in temperature will be less, it is still enough to make the wearer swelter more than he would if his clothing were not thermally active.

This observation is reported in an article in *Science* for April 10, 1942, by Drs. Jean H. Nelbach and L. P. Herrington of the John B. Pierce Laboratory of Hygiene in New Haven, Conn. Their point of departure was from certain well-known data of textile technology. The ability of textiles to pick up moisture has long been recognized as an important factor in testing, weaving, and buying yarn. Drs. Herrington and Nelbach experimented with a man's woolen garment weighing 1.86 kilograms (4.1 lbs.) when dry at 70°F. They had available a temperature and humidity-controlled room and delicate measuring instruments. The garment was allowed to come to hygroscopic equilibrium —that is, to lose or gain all the moisture it could, with the room set at a low relative humidity. It was then weighed and packed in an air-tight metal container, while the relative humidity of the room was raised to a comparatively high figure, the temperature being held constant. The garment was then taken out of the container, hung on a sensitive balance, and weighed at regular intervals. As it absorbed moisture at the higher humidity its weight increased.

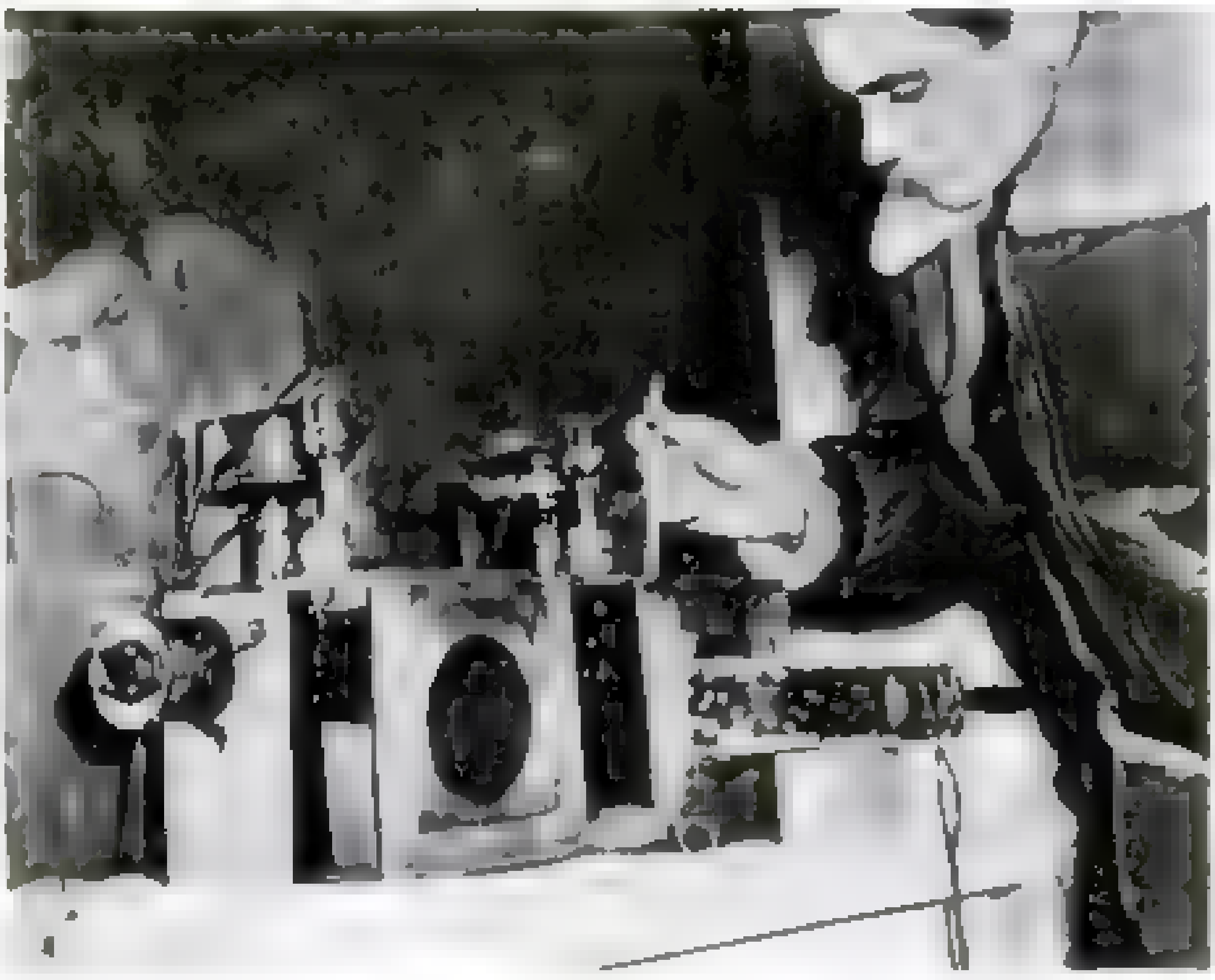
All this the textile technicians could do, and some of it they had done, if not with the same precision. But the textile technicians were interested only in the working qualities of yarn. They were not interested in heat and had no special equipment for rapid and accurate thermodynamic determinations. The John B. Pierce Laboratory, on the contrary, was primarily concerned with heat



MOISTURE ADDS WEIGHT

A thermopile measures the surface temperature of the clothing of a laboratory subject who has been pedaling a "workmeter" in a cold chamber to duplicate working or fighting conditions

In a heater unit, at the left, below, the thermopile is calibrated to give accurate readings on the galvanometer which is used to record results.



interchanges between human beings and their environment. Research scientists on its staff had been working for years on problems of the body-clothing complex regarded as a thermodynamic system. Consequently they were equipped to see some new relationships. Once they knew that comparatively large quantities of atmospheric moisture were absorbed, they knew that there must be correlated heating effects.

Why does the absorption of moisture evolve heat? Actually the phenomenon is not one of absorption in the strict sense. The textile does not pick up water like a sponge; it does not get wet. It takes in moisture by a process known as *adsorption*, which in Latin means "sucking towards." When adsorption occurs the molecules of a substance, in this case a gas or vapor, are attracted to the surface of another substance and adhere to the surface in a thin layer, without chemical combination. Charcoal, for example, being porous and offering a large surface area for a given weight, is used industrially to adsorb gases. Textiles adsorb water vapor in the same way. But we know from the kinetic theory of heat that the molecules of a gas are in vigorous motion. This motion represents energy. When water vapor is taken up by the cellulose structure of textile fiber, the flying molecules are immobilized, so to speak, and give up their energy in the form of heat. As long as molecules continue to collide with the fiber, heat will be evolved and the temperature will continue to rise.

For practical purposes, however, the important factor is the rate of change. The amount of heat liberated depends directly on the rate at which moisture is adsorbed. In the test described above, it was noted that during the first hour the garment gained about 75 grams (2.64 ounces) of moisture. During the second hour the gain was about 20 grams, and thereafter the gain per hour continued to decrease. After six hours little moisture was picked up, although the tests were continued in some cases beyond 24 hours. The fact that the curve is steep at first and that the slope decreases is what makes the effect significant. It means that the pickup of moisture, and the resulting heating, is concentrated during the first few hours and especially during the first hour. If the heating were spread evenly over a 24-

In a control room outside the test chamber, a technician follows the readings of the instrument. A microphone enables him to talk with the subject, who can call for help if he gets into difficulty. These tests are designed to show the efficiency of clothes for flyers, soldiers, and other specialists

hour period, say, the experiments would be of only academic interest. But with the garment gaining about 75 grams of moisture in the first hour, the heat liberated is found to be equivalent to that radiated by a 50-watt incandescent bulb. Thus the person wearing the coat absorbs as much heat during the first hour, simply from its moisture pickup, as if he were hugging a 50-watt bulb or heating pad, the only difference being that he is getting the heat distributed over the whole surface. Or, in physiological terms, he is getting almost half again as much heat from the coat as his body produces while at rest, purely as a result of the thermal activity of the coat when it picks up moisture at the rate shown.

This process is reversible. When a garment has taken up moisture at high relative humidity, it will lose the same amount when the humidity falls. In short, clothing, under conditions of varying humidity, acts alternately as a stove and as a refrigerator on a small but significant scale.

As far as human comfort is concerned, the result may sometimes be beneficial, but it is more likely, under our present conventions of dress, to be inconvenient. The pleasant side of the picture is represented by a man taking his overcoat from the hanger in a steam-heated office, where the relative humidity is low, and going outdoors where the humidity is likely to be considerably higher. Under these conditions the coat will adsorb moisture and the wearer will derive some slight heating effect which may be welcome if the day is cold. If, on the other hand, he is a businessman wearing a heavy three-piece suit in summer, a sharp rise in humidity will add to his discomfort, probably to a greater degree.

In general, it would appear that the thermal effect noted by Drs. Herrington and Nelbach is one more argument against heavy, formal summer clothing such as is worn quite generally by executives and sub-executives of large corporations in the seaboard cities of the United States, where high relative humidities prevail during the summer months. Women, with their lighter clothing, and men who wear lightweight two-piece suits in summer, are more in accord with scientific findings in this field.

In an entirely different environment, an aviator wearing a heavy flying suit for protection at high altitudes may suffer considerably and perhaps lose efficiency in action at low altitudes on a hot, humid day, either in or out of his plane. These thermal effects were, in fact, first noted in connection with research on military clothing problems on which the John B. Pierce Laboratory is working. They are purely a by-product of this type of research, and their present importance is not so much in the way of immediate improvements in civilian clothing as in the design of protective garments for military use under extreme conditions.

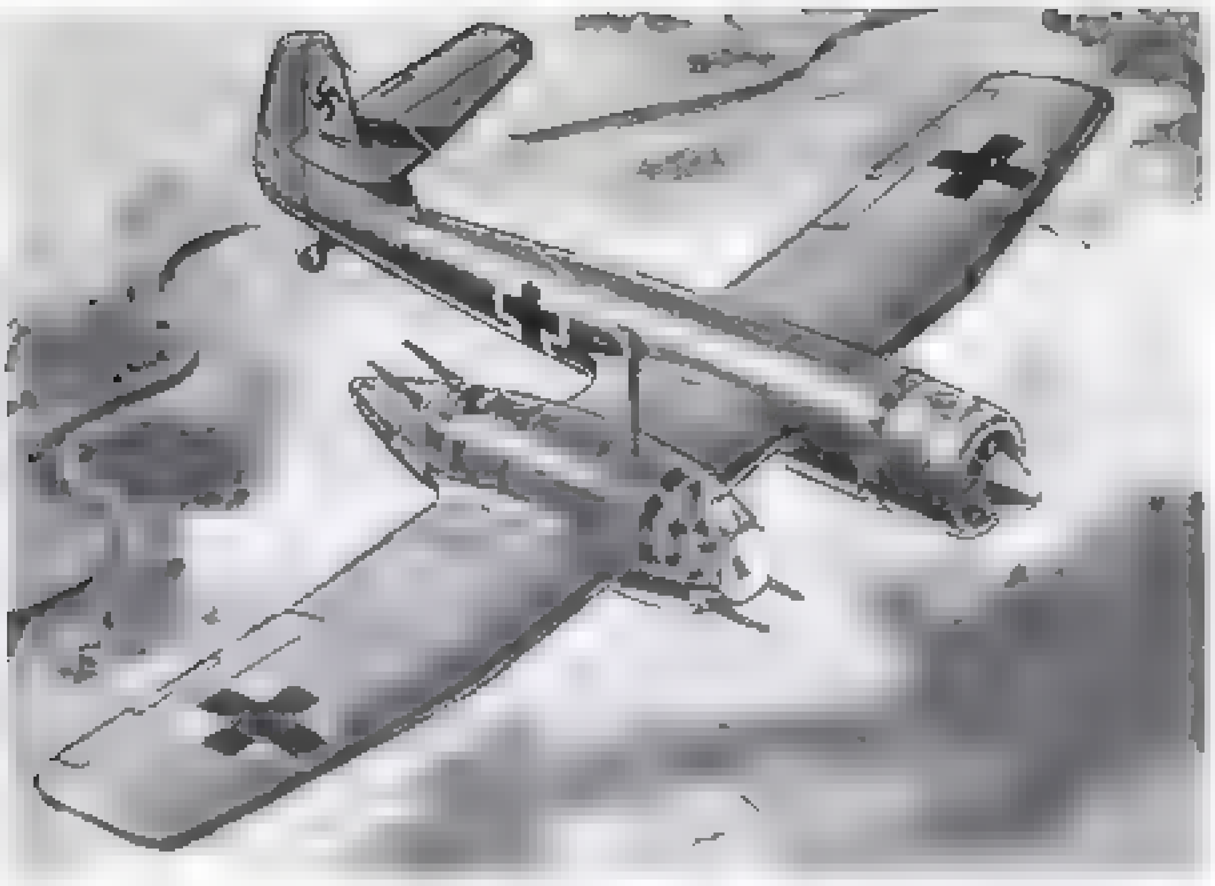
The basis of the Laboratory's work is that the body of a man, at rest or working or fighting, is essentially a heat machine, differing from a steam engine or other thermodynamic system principally in its ability to adapt itself to varying external conditions. Well-designed clothing assists this process of adaptation; poorly designed clothing hinders it. Instead of guessing at results and causes, the modern research worker measures what happens to the man, in much the same way as he measures temperatures and pressures, inputs and outputs of energy, in the steam engine. The purpose is the eminently practical one of enabling the wearer of the clothing to do his job more efficiently, just as research in steam engineering has increased the efficiency of locomotives and stationary engines.

The conditions under which men work

OSCAR'S HUMAN TWIN, below, pumps away at the workmeter running a generator whose output is the index of the energy expended. Another check is supplied by the oxygen breathed through the tube. At the right, the subject weighs in to see how much moisture has been lost. Findings are important to flyers who have to walk home from a ride in their flying togs

and fight can be duplicated in the laboratory by regulating temperature and humidity between tropical and arctic limits. A "workmeter" may be used to give an accurate indication of the subject's energy output. This apparatus is a kind of stationary bicycle in which the pedals drive an electric generator. The output power of the generator, measured by standard electrical instruments, shows the rate at which work is being performed. By measuring the oxygen consumption of the man doing the pedaling, the energy input to the man may be compared with the energy output of the generator. What happens to the man under these conditions is ascertained by means of thermocouples kept in contact with his skin by a harness worn under the clothing. Other electrical instruments of the thermopile type measure heat radiated from the skin of the face and the surface of the clothing. In some cases, where the conditions are too extreme for safe experimentation with human beings, an "Oscar" or thermodynamic robot is substituted. In place of lungs and blood vessels, Oscar has electric light bulbs calibrated to simulate the heat production of a man under various conditions of activity. All these devices and many others will enable us to get the most out of our resources of manpower, and to avoid such costly errors as those which the Germans, for all their vaunted scientific prowess, fell into during the winter campaign in Russia.

For the more distant future this and other developments in the scientific design and testing of clothing open up interesting possibilities. It may be asked, for example, whether hygroscopic materials like wool, which vary in their properties with the weather, may not eventually be displaced by synthetic materials better adapted to specifically human requirements. While wool is the best protection for a sheep, it is not necessarily the best for a man.



NEW WAR WEAPONS

WORLD'S ODDEST PLANE, the British call this German observation craft recently put in service by the Luftwaffe. Asymmetrical in design, it has two nacelles. One contains the single engine; the other, much shorter, accommodates the two-man crew. To balance the one-sided craft, only half a tail plane is used. Armed with two fixed guns in the nose and a cone turret aft, the plane can make 220 m.p.h. at 17,000 feet

$8 TOMMY GUN. Costing only eight dollars apiece, the Sten submachine gun, now in production for the British at a Canadian arms plant, is ideal for issue to saboteurs and patriots in occupied countries. It has a magazine holding 32 rounds and can fire at a rate above 500 rounds per minute. Eight loaded magazines weigh eight pounds

NEW U. S. TANK. Latest addition to America's tank family is the self-propelled gun mount seen at the right as it appeared in a recent parade on Fifth Avenue, New York. Resembling the nowfamous German assault guns, the new weapon provides armor protection for the gunner of its big piece, which delivers a heavier projectile than any gun carried by any other American tank

Cargo Planes for Victory

BESIDES FERRYING TROOPS AND WAR MATERIALS, THEY MAY HAUL EXPLOSIVES FOR MASS BOMBING

By ROYAL B. LORD
Colonel, Corps of Engineers, U.S.A.

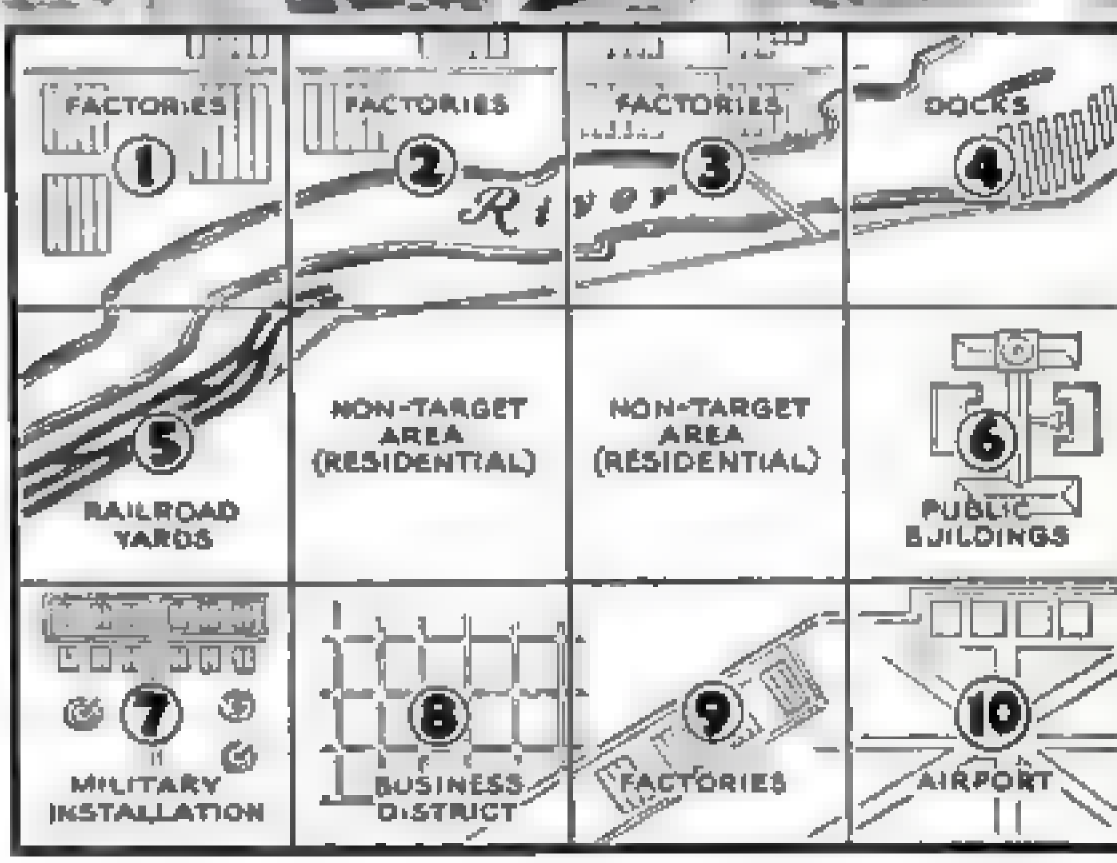
IN RECENT months a great deal of speculation has centered around the postwar role of cargo transport by air. Interesting and important as the discussion has been, one thing is still more important, and that is winning the war. We must not overlook the fact that cargo transport by air is a vital part of the war effort right now. Its expansion at the fastest possible rate is a prerequisite of victory. Moreover, as we shall see later in this article, cargo planes, effectively used in mass bombing operations, may well be the means of administering a crushing blow to German industrial power—and once German productive capacity has been destroyed or seriously impaired the end of the war cannot be far off.

Since March, 1942, the United States Army has been utilizing what is probably the hardest-working air cargo fleet in the world. The Contract Air Cargo Division is in charge of a former air-line official, Lieut. Col. Robert J. Smith, and functions as part of the Air Service Command under Maj. Gen. Henry J. F. Miller. The word "Contract" is in there because while the Army gives the orders, actual operation is left to civil air lines equipped to do the job. There are at present some 17 of these lines, with a personnel of over 20,000. Rather than build up its own specialized organization, the Army in effect took over more than an army division of highly skilled and experienced men who know all the angles of preventive maintenance and overhaul of planes, loading and unloading of freight, dispatching, communications, etc. So organized, this fleet carries both freight and passengers for the Army, Navy, and all Federal agencies directly engaged in war work.

Routes operated within the United States form the hub of a wheel from which spokes radiate to Alaska, Greenland and Iceland, Trinidad and Natal, and Panama. The Air Service Command operates only in the Western Hemisphere. Service to bases abroad, in or near combat zones, is in charge of the Ferrying Command of the Air Corps under Brig. Gen. Harold L. George. The Ferrying Command is already spanning 10 times the number of miles covered by all the world's air lines at the start of the war, and flying supplies, mail, personnel, and planes to American and United Nations forces all over the world. The cargoes consist of such items as ordnance supplies, fuses, armor plate, parts of jeeps, blood plasma and other medical supplies, extra-priority materials, and bottleneck-relieving stuff generally.

The Army has a four-engine cargo plane, the Douglas C-54, in production. Three types of cargo planes are now in use—the C-53, which is essentially a converted DC-3 transport, and the smaller Lockheed Lodestar and Boeing 247. These planes carry payloads of 3,000—5,000 pounds. The Contract Air Cargo Division has many such planes in daily service, each averaging 1,500 miles a day. The total of ton-miles per week is very little compared with, say, railroad tonnage hauled in the same time. But this service must not be judged by the number of planes in actual operation at the moment, nor by the load capacity of each plane. It is essentially a nuclear organization.

Winning the war calls for a production schedule of cargo planes which must be well under way in nine months and at maximum output in 18 months or less. These planes will not be C-53's. They will be much larger than anything we now have in the commercial field. The ratio of payload to gross weight must be increased — which means big planes. The C-53, gross weight about 12.5, will carry some two tons of cargo on a 2,000-mile trip. The useful load



BOMBING WITH CARGO PLANES. Flying in the wake of waves of armed bombers and escort planes that have silenced all resistance, cargo planes can dump tons of explosives on a helpless target area. A grid plan like that seen at right would serve as a template for rough pattern bombing of objectives

in this case is, therefore, around 16 percent of the gross weight. For shorter jumps the ratio may be 25 percent or even higher. But the cargo plane strategists still shake their heads. They want more than 16 per cent and more than 25 percent.

They are thinking—for the time being—in terms of planes with gross weights between 32.5 and 50 tons. With planes of this size, the engine drag and aerodynamic interference are appreciably less; the plane is faster and carries more payload in relation to its gross weight. Minimum payload should be 10 tons. The big plane must replace the little plane for carrying purposes. A 32.5-ton plane will perform somewhat as shown below:

Distance	*Gasoline Load*	*Cargo Load*	*Ratio of Cargo Load to Gross Weight (38 5 tons)*
1,000 miles	3 tons	16 tons	50 percent
2,000 "	6 "	13 "	40 "
3,000 "	9 "	10 "	31 "

(Continued)

Looking like a school of whales a line of cargo-plane bodies in the factory await their wings and engines. Our production schedule on these freighters of the sky will be at its maximum within 18 months

These figures are more or less conjectural and are given only for purposes of illustration, but the principle is clear. The 32-ton plane will jump 3,000 miles with a better ratio of cargo to gross weight than the C-53 can show at 1,000 miles. A 40-percent ratio at 2,000 miles is what the freight-plane designers regard as a feasible standard right now. Later, with still larger airplanes, they may do better.

Another compelling reason for going to big aircraft for carrying purposes is that they are easier to manufacture. These air freighters are to be built not by tens or hundreds but by thousands and tens of thousands. A project like this

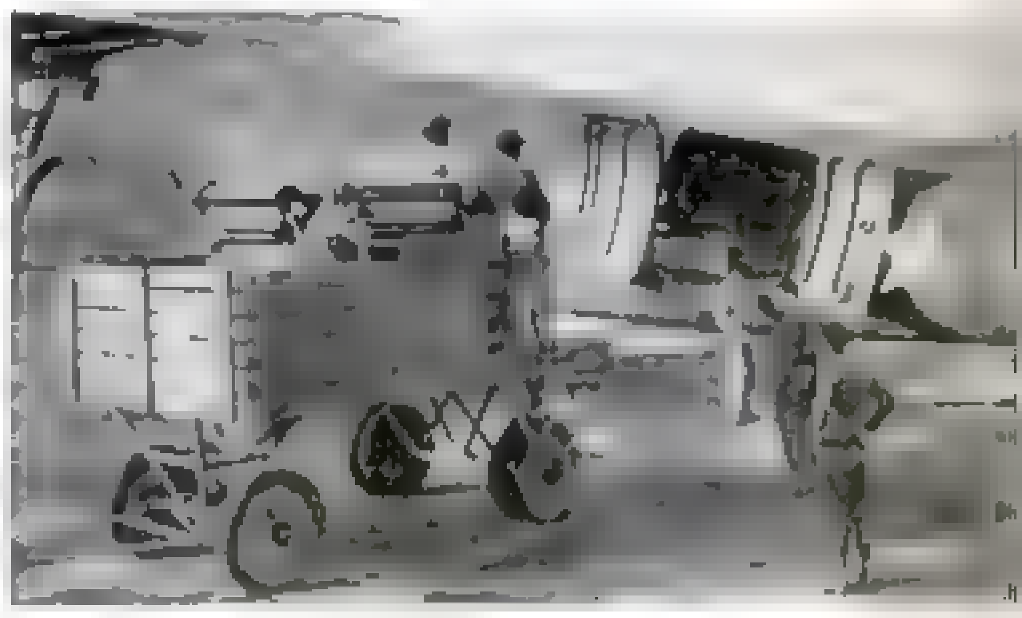
Four types of cargo planes. Top to bottom Beechcraft C-45, Lockheed C-40, Douglas C-41, Curtiss C-46. The last-named can carry 50 or more fully armed troops or 9½ tons of freight, with a long range and high safety factor. A four-engine cargo plane is now in production for the Army, the Douglas C-54. Designers now are aiming for planes of gross weight up to 50 tons and useful-load ratio above today's best figure of 16 percent (25 percent on short hauls)

MATERIALS: Spot-welded low-carbon steel, seen above in contrast with riveted aluminum alloy on an adjoining wing section, saves the lightweight metal for use on combat planes. Right, testing plane parts of plywood plastic

immediately runs into stupendous figures in man-hours and materials required. Our fighter and bomber designs are all based on the use of aluminum, and that material is very much on the scarcity list. Even if it were the best material for cargo planes, it would be unobtainable in the quantities required. Plywood, then? For trainers, yes; perhaps for some cargo planes also—but better not put too many eggs in that basket. The answer, then, is steel. These planes are just flying boxcars, and, like boxcars, can be made of steel.

Two types of steel are now acceptable for plane construction—stainless steel and low-carbon steel. Stainless steel is already being used in the construction of some 900 small cargo planes. This type of steel, however,

Loading Sky Freighters with Cargoes for Fighting Fronts



A big plane swallows a little one: At left, a complete set of wings for a Piper YO-59 "Grasshopper" being stowed in an Army cargo ship for transportation from the factory. Right, preparing to load a pair of Allison liquid-cooled engines into a C-47. How these are handled is shown in photographs below

When plane engines have been put through the cargo door, a pulley is attached to a ring near the ship's nose to drag them forward

Here an engine is in place and its wheeled carriage has been bolted to the floor, taking the weight off the wheels and securing it for the flight

Ropes also tether the carriage to rings at the side and miscellaneous cargo is stowed in spaces around it

uses critical materials such as nickel and chromium.

Low-carbon steel appears to offer the best solution to the problem. A series of studies and tests of low-carbon steel has proved conclusively that this material can now be used for such construction. Its use entails no weight handicap and no difficulty with corrosion. Low-carbon steel welds easily (over 50,000 tests with no spot failures). It is easily handled and formed by conventional shop methods. Steel production capacity is now about 90,000,000 tons per year. Two hundred steel air freighters per month require only 2,000 tons of steel per month. There is idle rolling-mill capacity for airplane-size sheet. There are many concerns with available manufacturing capacity such as automobile, refrigerator, stove, and many others thoroughly familiar with the technique of manufacturing in this material. This makes available men and facilities in large quantity. Extensive tests have proved that corrosion is not a serious problem. The material welds perfectly through the corrosion treatment.

Welded steel construction permits the production of at least two airplanes for the same amount of labor and facilities now necessary to produce one airplane. For example, in aluminum, a fin required 8½ man-hours for completion in an airplane plant. An extensive study by automotive planning engineers reduced this to 2½ man-hours by the use of elaborate jigging. The same part was actually constructed in steel with 12 *minutes'* labor.

The basic structure of a military airplane is a comparatively small portion of the total weight. In the freighter a much larger portion of the total airplane is basic structure. Consequently it is certain that a much greater saving than two-to-one can be effected with quantity production of cargo planes when steel is employed.

With the stiffness of the low-carbon sheet used in this structure, the skin is very smooth, producing greater aerodynamic efficiency. Other advantages are obvious, such as the fact that it is possible to cut out large sections of the structure and weld in replacements for damaged parts in the field with portable equipment.

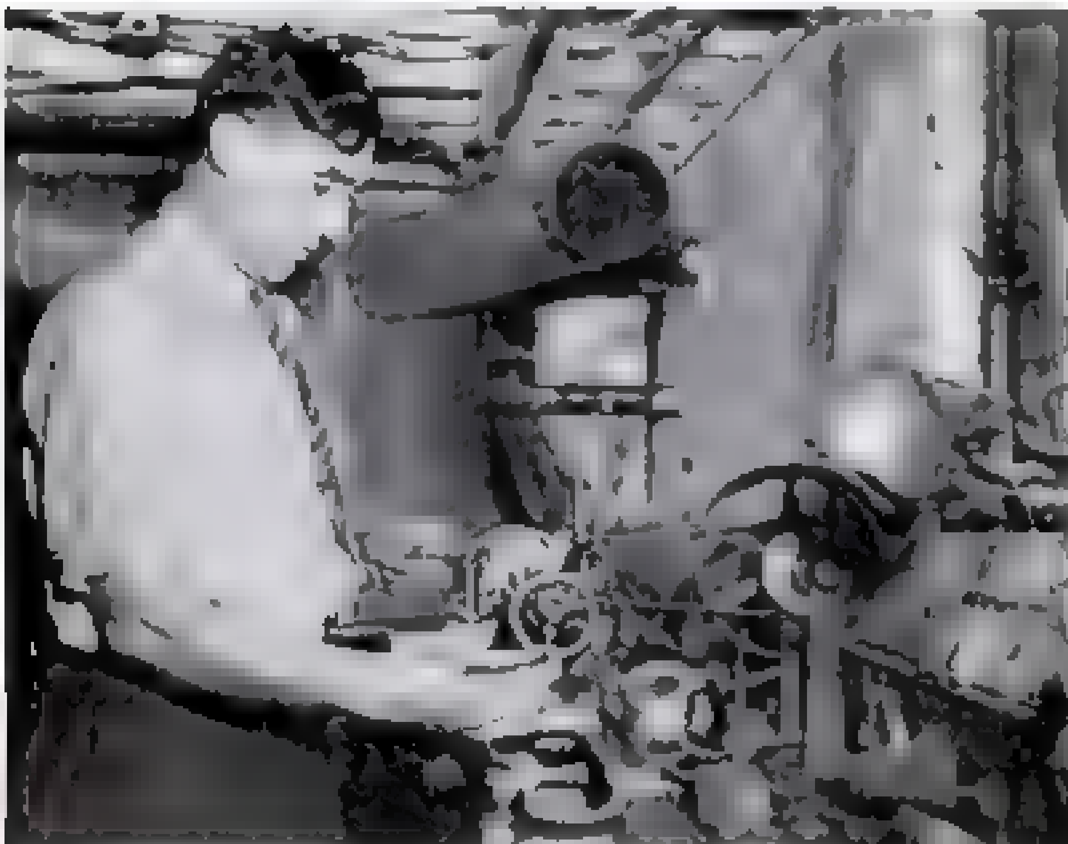
Cargo planes can transport urgently needed supplies at high speed to our own forces abroad and to those of our allies, free from the submarine hazard, without convoying, zigzagging, or other time-consuming expedients. Forty cargo planes carrying 12.5 tons apiece can deliver 500 tons of strategic material in Europe *overnight*. Likewise they can carry troops. As we have seen, such an air-express service is already being operated, at present on a relatively small scale, which should be greatly expanded in the near future. But there is another job which cargo planes are capable of doing. It is based on the theory that mass bombing operations may be carried out most effectively in two stages: reduction of defenses, and dumping of explosives. The first is a military procedure and must be left to escort planes and bombers of the regular types. The second is essentially a demolition-engineering procedure which calls for the use of large, comparatively cheap cargo planes. So used, bombers of standard design, and cargo planes equipped with bomb bays and simple aiming devices, can complement each other to produce demolition effects which will make the Nazi practitioners of aerial terrorism regret that they ever went into the business.

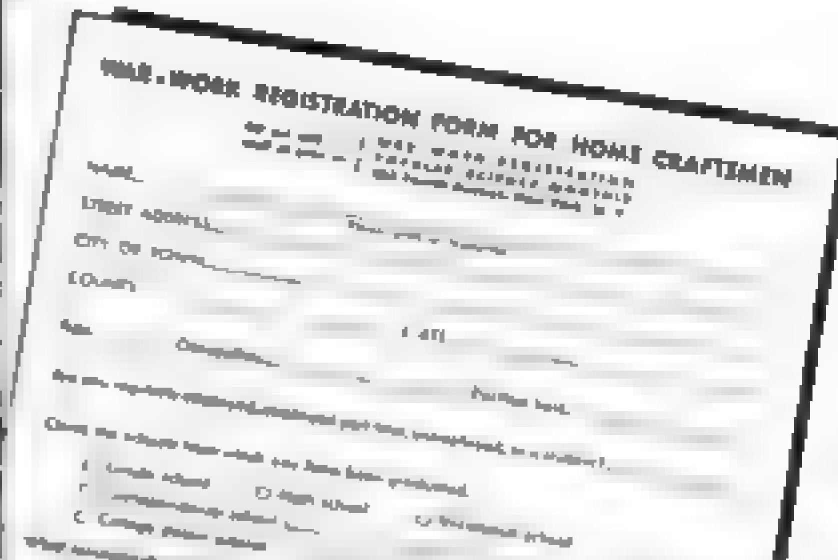
The conventional bomber must be able to defend itself against hostile planes. It therefore carries a large proportion of its weight in the form of armor and armament. But for every pound of ordnance, ammunition, and protective armor on board, a pound of bomb load must be sacrificed. The bomber's primary function — its ability to destroy ground objectives—is therefore limited by its defensive structure and equipment. For this reason, among others, some military authorities have concluded that bombing raids against objectives more than 800 miles distant from base are in general unprofitable.

The heavy cargo plane upsets this conclusion. Suitably equipped, it can carry and release bombs to the full extent of its cargo capacity. And what is the sense of using a Flying Fortress in a situation where nothing remains to attack it? Once the AA and fighter-plane defenses of an area have been practically put out of commission, why continue to fly in bombers bristling with machine guns and cannon? At this point in a major bombing operation, when the target is undefended and aerial attack is at the peak of its destructive power, cargo planes may be flown in en masse with a minimum of risk and a maximum of explosive load. Instead of directing a force of a thousand bombers and escort planes against an industrial or military center and calling it a day, we can start off with those planes, or enough of them to disrupt communications, plaster air fields and AA gun emplacements in the neighborhood, and set fires, and then, before mobile AA equipment can be moved into the area, finish the job with another thousand, or two or three thousand, cargo *(Continued on page 215)*

Small Shops Prove Good Pinch Hitters in War Work

THEY TACKLE MANY TRICKY LITTLE TIME-CONSUMING JOBS . . . POPULAR SCIENCE READER KEEPS ENTIRE FAMILY BUSY ON MACHINES . . . RETIRED FOUNDRYMAN CASTS NAVY "HOWLERS"





WAR-WORK REGISTRATION FORM FOR HOME CRAFTSMEN

DAVID NEIL, A POPULAR SCIENCE registrant, centers ⅝" steel rod to make special locking screws in basement shop. At right, Mrs. Neil cuts straight steel pins on a small hand milling machine. Their son David, 18, helps, as does daughter Constance, 21

WHAT can small shops do best to help the nation's war effort? This question has cropped up frequently in the course of the survey of small-shop facilities being made by POPULAR SCIENCE for the War Production Board. There is no single answer because the small shops already at work have displayed amazing ingenuity in tackling all sorts of tricky little jobs.

Here are a few examples

CASE 1. David Neil, 54, repaired magnetos for planes and car generators while serving with the A.E.F. in France during the first World War, and has been repairing automobile generators and winding armatures in a small shop for twenty years. He filled out a POPULAR SCIENCE war-work registration form shortly after the survey started. His number was 5848. The form first went to the Washington offices of the WPB, then was forwarded to E. O. Kuendig, manager of the Canton, Ohio, office of the Contract Distribution Branch. Arrangements were quickly made for Neil to put slots in tapered pins and later to cut straight pins—about 20,000 pieces altogether. The next job was for special locking screws required by an ordnance plant; they have to be machined within a tolerance of .002". All the work, in fact, requires a high degree of precision. The entire family helps. Mrs. Neil, after doing her housework, puts in five or six hours at the milling machine. A daughter, Constance, 21, does buffing. Neil's son David, 18, works on the miller and other machines. The shop is 26 by 38 feet in the

Frank Lazzara specialized in macaroni machines before the war, then discovered they could be used for making macaroni-like insulation for airplanes. Here one of his workmen takes a micrometer reading on part of an insulation die. Lazzara's work is now 90 percent for war—mainly subcontracts supervised by the New York Ordnance District

basement of his bungalow. His equipment includes two lathes, hand milling machine, power hack saw, three arbor presses, one large drill press, two small drills, and an electric test bench.

CASE 2. Converting macaroni machines to serve in the war effort is what happened in one small machine shop in an Eastern city when a government order froze its stock of reconditioned presses. With an eye to the future, Frank Lazzara, the owner of the shop, had his men change the macaroni machines so they would press out plastics and ceramics. It wasn't long before a large contractor, who had been given a contract by the New York Ordnance District, walked into the place and asked Lazzara if he could tool dies for making macaroni-like insulation for airplanes. Except for their size, the dies were similar to those in the macaroni machines, so Lazzara took the job. Today the shop is doing about 90 percent war work. Eight regular employees and one new man are all busily producing, not only insulation, but a number of machine parts for different manufacturers.

CASE 3. Arthur W. Brooksbank, mechanical engineer, a veteran of World War I, obtained a small shop in New Jersey, solicited orders for airplane parts, then mobilized a dozen small shops to aid in the work. The smallest is in the cellar of a horologist, 78 years old, who makes instrument housings when he isn't busy repairing clocks. The largest shop is in a shed, but contains considerable machine-tool equipment. Altogether Brooksbank is making more than 200 different "bits and pieces."

CASE 4. Benjamin Franklin Harpel, 77, who sold a small foundry in New Jersey and retired six years ago, converted a two-story chicken house and garage in the back yard of his home into a miniature aluminum foundry. With the assistance of a helper he is casting "howlers" —the sailor's name for sirens—and switch boxes for the Navy

CASE 5. Dr. Joseph H. Bair, a psychologist, writer, and inventor, with the aid of his son, Richard, 27, and a few neighbors, is working on a subcontract—a single operation required in the manufacture of a bomb. His home shop, which is in a small Pennsylvania town, hums day and night, and he manages to keep right up with his prime contractor, which is a large manufacturing plant.

CASE 6. A naturalized Norwegian boat builder and cabinetmaker of New York City, who retired five years ago, has a back-yard shop with a wood-turning lathe, planer, shaper, grinder, engine lathe, and various power-driven tools. He is making hasps from hard English clock brass and other hardware for a canvas firm doing Government work, and also building wooden drafting and office furniture for the same company.

* * *

If you wish to register in our war-work survey, send a stamped, self-addressed envelope for a blank to War-Work Registration, Popular Science Monthly, 353 Fourth Avenue, New York.

Explosives for the War

All explosives get tests to see how they'll stand conditions of travel or storage. Below, test samples in a moisture cabinet

By CARL DREHER

BEFORE you can throw it at them you have to get it out of the ground. That is the phase of the explosives industry which most of us neglect in wartime. We picture the belching guns, the exploding shells and bombs—that, we say, is war. It is—but only a part. If we want to know real war, total war, we must consider where the metal for the bombs and guns comes from in the first place, and not only the metal, but all the other raw materials which go into the business of fighting. Then it becomes clear that military explosives are only one side of the picture: without industrial explosives we could never get the needed raw materials in time.

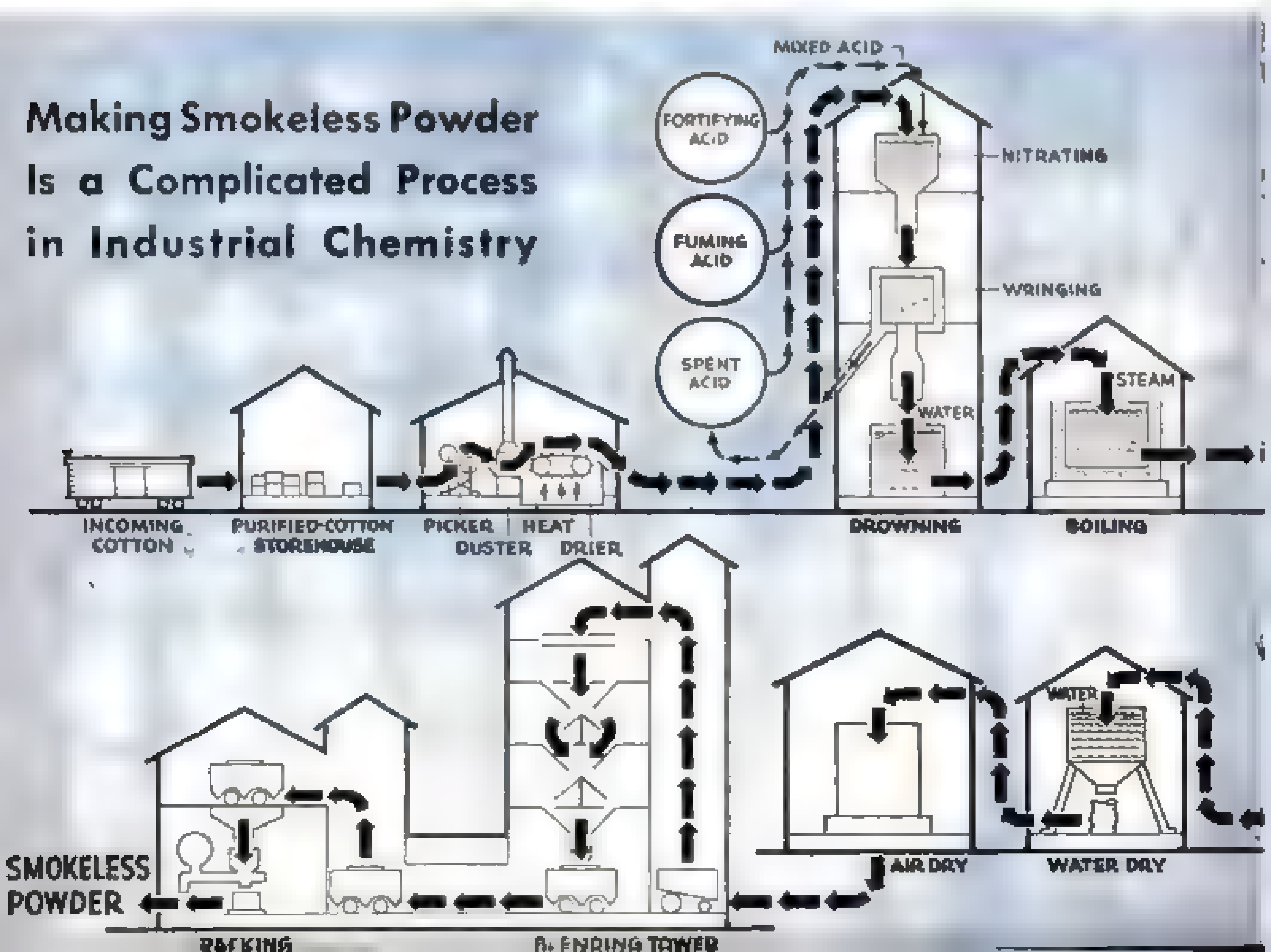
A commercial or military explosive must be a great deal more than merely an explosive. It must explode, but not too readily. Nitrogen iodide, for example, is a brown or

Making dynamite: Ingredients are mixed in this unit for experimental purposes in a Du Pont laboratory

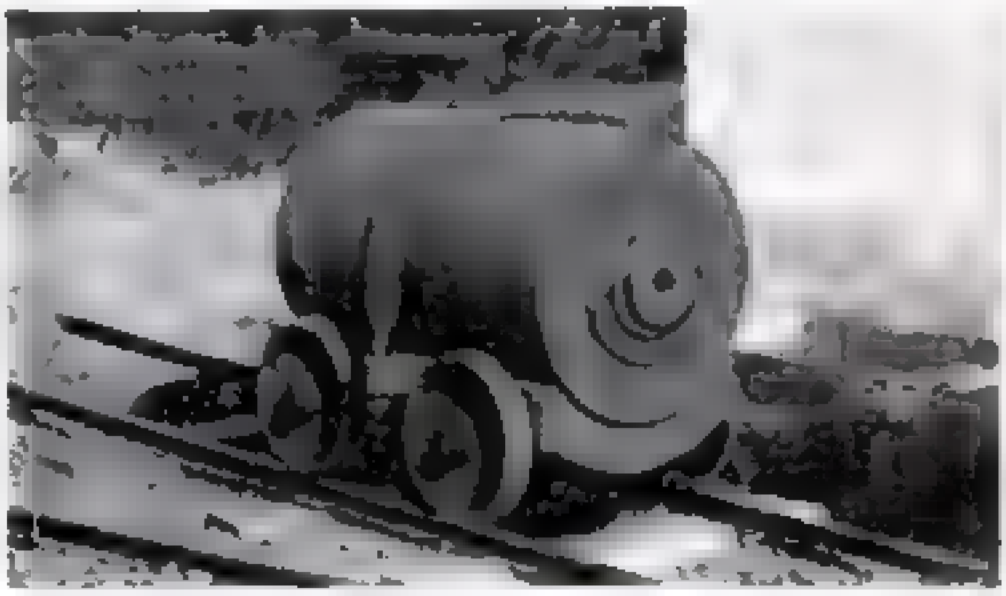
black powder made by the reaction of ammonia with iodine. A quantity which can be heaped on a dime, when tickled with a feather or merely shaken by the passing of a truck, will explode and wreck the room in which it is located. Obviously nitrogen iodide is not to be recommended as a commercial explosive. In the lingo of the explosives engineer, it is too "touchy" for commercial use.

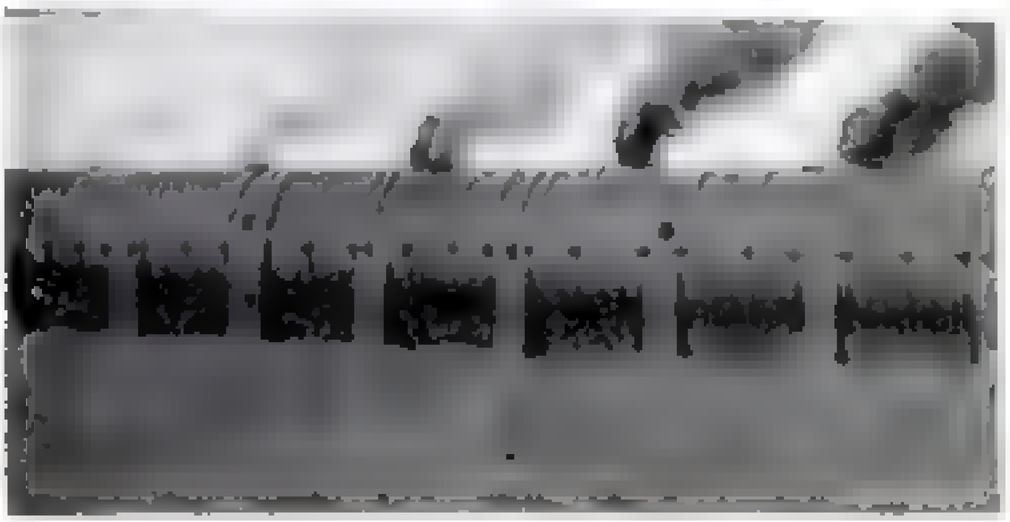
Nitroglycerin comes closer to the commercial classification, but is still much too sensitive and dangerous for general use. By far the most widely used commercial explosive is dynamite. Dynamite is a general term; it is more realistic to speak of dynamites. The original dynamite invented by Alfred Nobel 75 years ago was simply nitroglycerin absorbed by a base or holding material—a "straight" dynamite. When the nitroglycerin is replaced in part by ammonium nitrate (NH_4NO_3), the explosive is known as an ammonia dynamite. A third important class of dynamites is the gelatin type, or blasting gelatin. This, also a discovery of Nobel's, is made by nitrating cotton and dissolving it in nitroglycerin. It is the most powerful explosive known.

All these types are graded in strength according to the explosive content. Thus a 60-percent dynamite is stronger than a 40-percent, and a 50-percent or medium



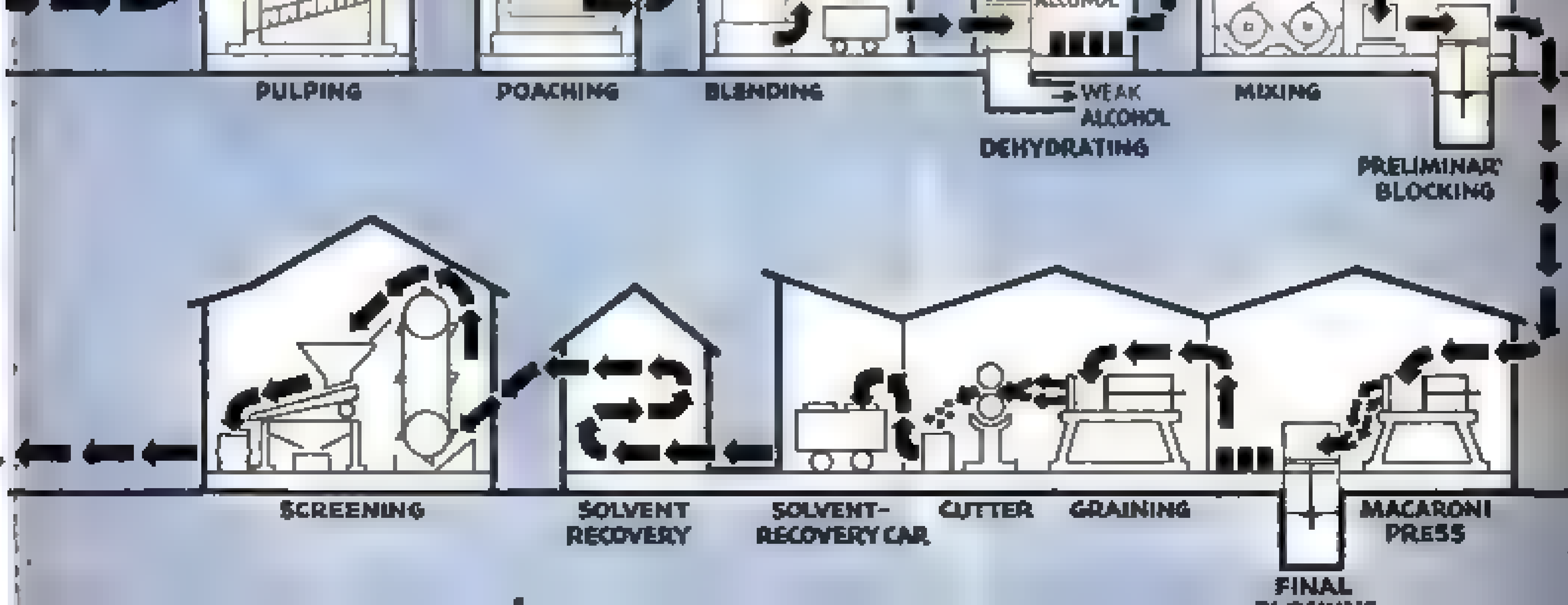
In the early days of research in explosives, test charges of dynamite were placed in the steel mortar, below, and exploded in the experimental test gallery which reproduced conditions found in mines





Strength of an explosive now is measured in the ballistic mortar, seen being loaded above. The recoil from the blast causes the pendulum to swing, registering kick on the scale at bottom

HOW SMOKELESS POWDER IS MADE. The flow chart below shows, in somewhat simplified form, the steps involved in turning cotton into nitrocellulose or guncotton. Extremely close chemical control is required at every stage, and enormous quantities of raw materials are used. It takes more than half a pint of alcohol to make a pound of powder, and an army of 1,200,000 men in the field needs 600,000 pounds of powder a day. Much of the alcohol comes from sugar—which explains your ration card



dynamite lies in between. The weakest type that will do the job is normally used. In coal mining, for example, the aim is to get large lumps of coal, and a weaker or slower explosive, which will not produce too much shattering effect, is preferred. The action of ammonia dynamite is controlled also by varying the size of the grains of ammonium nitrate. The smaller the grain the greater the speed of detonation and the greater the shattering effect.

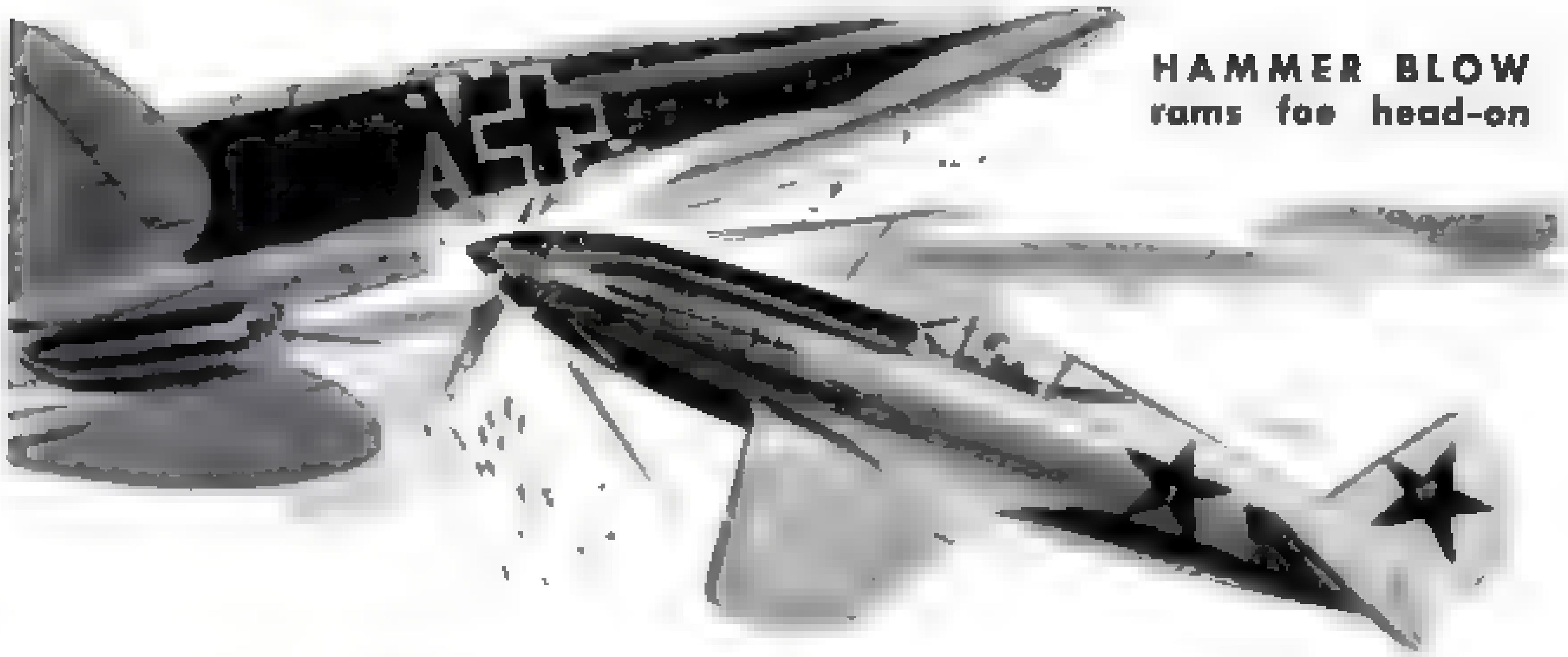
Dynamite is not easily exploded. Properly handled, it is so safe that almost 200,000 tons a year are carried on the railroads without mishap. In normal use it is exploded by means of blasting caps or detonators, which are small charges of high-velocity, violent explosives. These are sensitive enough so that they may be fired by means of a fuse or the passage of an electric current. The latter is preferred, since it permits absolute control of the time of firing and simultaneous firing of a number of charges by series connection of the caps.

Between the industrial explosives which we have discussed and the military types there are outstanding differences. Military explosives are essentially precision explosives. In war, the least variation in power may be disastrous, resulting in misses which may lose a battle or a campaign, or in such mishaps as the delivery of fire on friendly troops or the bursting of guns.

Military explosives are largely chemical compounds—TNT, for example, is a definite chemical compound like potassium cyanide or sulfanilamide. Thus there is only one TNT. Dynamite and other industrial explosives, on the other hand, are mechanical mixtures of ingredients in various proportions. The physical requirements are likewise quite different. Successful military explosives must stand all kinds of abuse, since the conditions of war are not conducive to extreme care in handling and protection from shock. If a dynamite is known to be explosive when a rifle bullet is fired into it, the risk can well be taken, but a military explosive is almost sure to be exposed to bullets flying in its neighborhood, and the enemy will not heed a danger sign on a magazine. For this and other reasons, military explosives are in general extremely insensitive. TNT in a shell, for example, is normally exploded by a fuse which sets off an explosive of the initiator type, like mercury fulminate or lead azide (PbN_6), which in turn fires a larger charge of an intermediate explosive like tetryl, which finally explodes the main charge of TNT.

There are two main classes of military explosives—propellants, which have the function of propelling projectiles from guns, and high explosives or disruptives. The industrial explosives which we have been considering are disruptives, and explosives of the same type are used for similar purposes in military operations like demolishing bridges and other structures. Likewise explosives used as shell fillers are disruptives, since the purpose is to burst the shell when it reaches its destination. The essential difference between a propellant explosive and a high or disruptive explosive is in speed of decomposition. The disruptive explosion is of high order, i.e. the velocity of propagation of the explosive wave through the substance is around 7,000 meters per second. The propellant explosion is relatively slow, and it is easy to see why it must be. A large projectile may weigh a ton or more. If a high explosive like dynamite were used to propel it the gun would inevitably burst. It would be like trying to get a string of freight cars into motion at full speed with a single jerk—something would have to give. To send the projectile on its way a comparatively slow, "progressive" explosion is needed, something which will build up to a maximum pressure in a small fraction of a second, but still very gradually compared to a TNT or dynamite explosion. The heavier the projectile, the slower the explosion must be. This is controlled by varying the size of the particles of powder, just as we saw that the size of the particles of ammonium nitrate controls the speed of explosion of ammonia dynamites. Thus small-arms powder is fine-grained, while the "grains" of powder for a 16-inch gun are good-sized cylindrical chunks. Pistols, rifles, machine guns, and the smaller calibers of cannon take fixed ammunition, in which the cartridge case contains both the projectile and the propellant powder. The familiar pistol or rifle cartridge is an example. Larger-caliber cannon use separate loading ammunition, the propellant charge being placed in the chamber of the gun in silk bags, after the projectile has been seated in the bore.

The traditional propellant, black gunpowder, is a mixture of charcoal, sulphur, and either potassium or sodium nitrate (KNO_3 and $NaNO_3$). Its modern military uses are slight, being confined largely to saluting and blank-fire and a few technical applications. For other purposes it has been superseded almost entirely by smokeless powder. The trouble with black powder is not only the volume of smoke, which betrays the position of the gun to the enemy, *(Continued on page 210)*



HAMMER BLOW rams foe head-on

Daredevil Russian Flyers Ram Big German Bombers

BUZZ SAW. Prop chews enemy's tail

AERIAL RAMMING, a new fighting tactic developed by daredevil Russian aviators, is helping to whittle down the German air fleet on the Eastern front. Maneuvers call for consummate skill. Neatest trick, the "buzz saw," is to creep up behind an enemy craft and use the propeller to slice off his tail controls. The victim crashes; the attacker may get back home with a bent propeller. In the "sickle thrust," the attacker clips the enemy with a wing or other part of his plane; the "hammer blow" rams him head-on. In either case, the attacking plane usually is wrecked—worth while for a bomber—and the pilot saves himself by 'chute. Ramming serves well to keep a crippled enemy plane from limping home if his pursuer is out of ammunition.

SICKLE THRUST. Attacker clips a wing

America Grows Her Own Drugs

Plowing a field for planting belladonna, on a large drug farm near Philadelphia, Pa

Hundreds of kinds of herbs, many of them new to the U. S., are grown on the small herb farm seen below at Milford Conn.

NEW INDUSTRY AIMS TO REPLACE SOURCES CUT OFF BY THE WAR

By BRUCE ALLEN

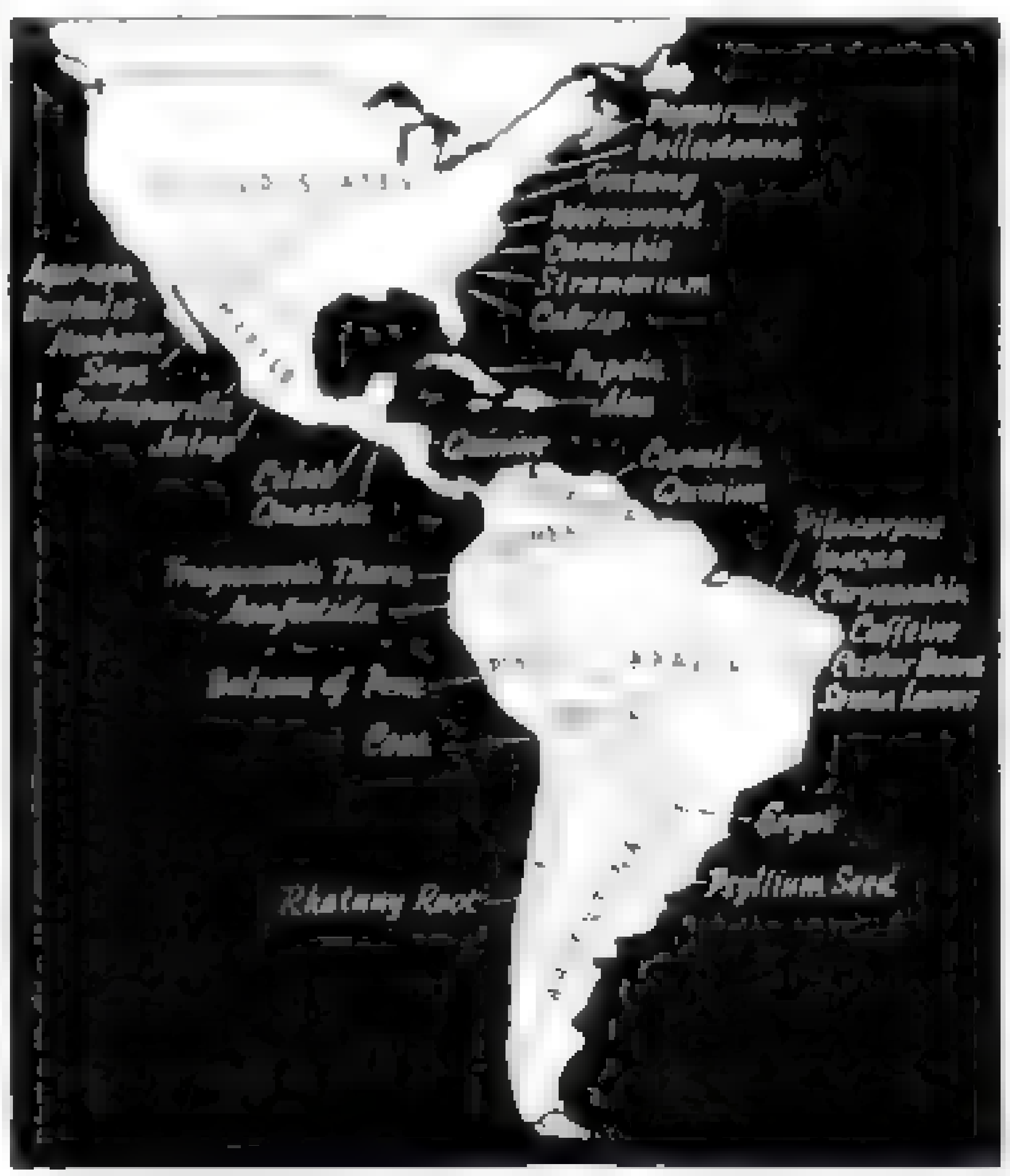
RUBBER is not the only essential product cut off by the war. Some 600 roots, barks, berries, leaves, gums, and seeds once floated in ship bottoms to American ports have also been struck from our import lists, and they constitute a large proportion of our drug supplies.

But while rubber cannot be grown overnight to fill our needs, many of the drugs either can be or are being home-grown in rapidly increasing quantities, and the steps that have been taken promise to make our sources adequate and the country independent of foreign-grown supply.

Of the drugs we cannot grow here, many can be produced in Latin America. Duplicates of others are being produced chemically. And self-sufficiency appears certain before present stocks are exhausted.

It does not mean, however, a return to the colonial herb garden, slack standards, and almost superstitious faith in plant remedies. Standards of quality remain rigid. Scientific production is required

Drug Plants of Western Hemisphere



for cultivated herbs. For the most part they are a specialty crop, requiring intensive care, not adaptable as a by-product for the casual farmer.

Belladonna, whose principal use is to dilate the pupil of the eye, rated by Prof. William J. Bonisteel, botanical expert at Fordham University, as one of the four most important drug plants, is under cultivation in New England, Pennsylvania, and California. The production of Atropa belladonna, however, requires care.

This poisonous perennial herb of the nightshade family requires deep, moist, neutral loam. Seedlings must be at least 20 inches apart. The first year yields only one crop. Thereafter there may be two or three annual harvests. After being gathered the plants must be dried separately in a shaded room almost devoid of humidity. They lie on racks until the leaves can be pulverized between the finger tips and then are baled or sacked for shipment.

Improper drying impairs the value of the plants. During their growth they must be watched carefully, for the common potato beetle finds the seedlings toothsome and whole fields have been ruined by their depredations. Moreover, 300 carefully cultivated acres could supply the entire demand in the United States and over-production would cut prices ruinously

1 Here are 15,000 belladonna seedlings in a greenhouse at Sharpe & Dohme's Pennsylvania farm. Each plant is kept in an individual wooden frame until it is big enough to be set out in the field

2 The two-year-old plant at the right is ready for gathering. U.S.P. standards require plants to be harvested before stems exceed 10-mm. diameter

3 After harvesting, plants are washed thoroughly and placed on drying racks like that shown below. These racks go into a shed where the plants remain until they are dry enough to be pulverized

4 From the farm at Glen Olden, Pa., pulverized plants are shipped to the Sharpe & Dohme factory in Philadelphia. Here a pharmacognosist is taking a sample to test for identity and quality

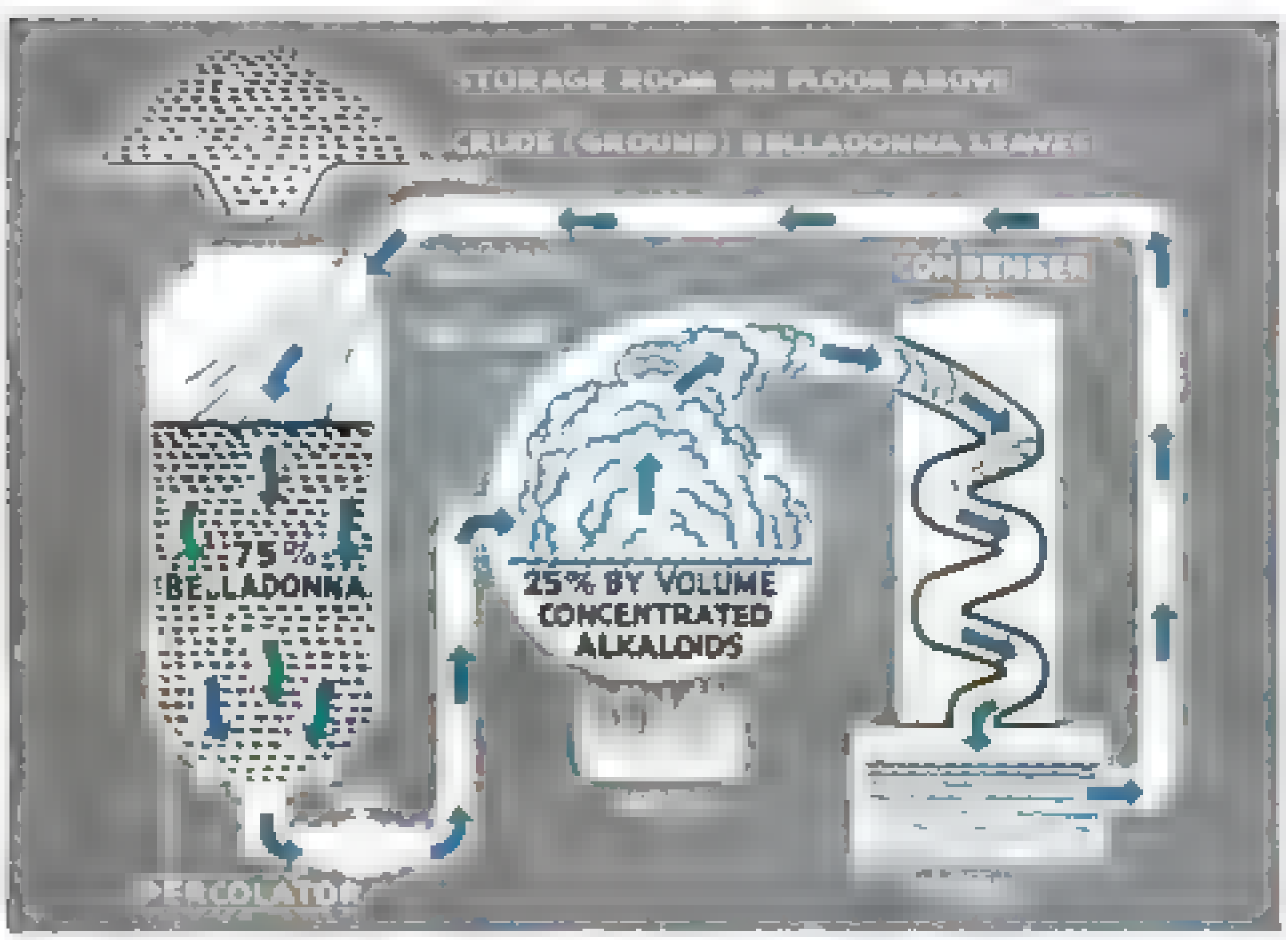
The other most important drug plants, according to Professor Bonisteel, are digitalis, a heart tonic; stramonium, an asthma remedy, and henbane, an antispasmodic. Professor Bonisteel says that intensive cultivation of 1,000 acres would produce enough of these four leading drugs to supply the needs of American manufacturers. Northwestern farmers already are gathering the wild foxglove, whose leaves and stems yield digitalis. Stramonium comes from the Jimson weed, which grows rank over a large part of the United States.

Quinine is another important drug whose principal, though not original, source has been cut off by the war. For many years supplies came largely from the Dutch East Indies, though the cinchona tree, from whose bark it is derived, is a native of South and Central America and its medicinal qualities were discovered first in Peru. Importation of saplings into the Dutch East Indies and intensive cultivation there, however, yielded a product so far superior to that of the trees growing wild in South America that the world became more or less dependent upon the new source. Now steps are being taken to cultivate the tree in Latin America. Not more than 2,000 acres, it is estimated, would be needed to supply the United States.

The black soils of southern Michigan and Indiana have for years yielded crops of peppermint for peppermint oil, and spearmint also is grown there in quantity. Sage is another herb which has been cultivated somewhat sporadically in the United States for many years. Some years ago Japanese peppermint, natural source of menthol, was grown on several hundred acres in California, but prices fell and its cultivation lapsed. A new chemical process for the production of menthol from a coal-tar derivative will supplant the importation of almost 500,000 pounds a year from Japan.

China used to be the source of ephedrine (Ma-Haung) plants, from which is made an astringent solution for clearing the nasal passages. The plants were imported in great quantities. Since this supply was shut off, American chemists have developed a substitute, said to be equally good, in quantities to meet the needs of the country.

A chemical substitute for the Oriental



5 To extract a tincture of belladonna, the crude drug is poured down a chute into one of the huge copper kettles, or percolators, seen above. Alcohol is then poured in until the kettle is full

6 After the mixture has steeped 12 hours, the liquid is drawn off from the bottom of the percolator into a vacuum still. Concentrated alkaloids remain in the still and alcohol is recirculated through the percolator

poppy used in the manufacture of morphine has been discovered also. The new drug, known as Demerol, begins to act within 15 or 20 minutes after being administered and is effective for as long as six hours. It is described as habit-forming but lacking the element of physical craving engendered by morphine.

Fifty countries from which the United States got more than 55 percent of its crude drugs have been cut off from commercial communication by the war, but there is every prospect that, with the imported products now in storage, the United States will feel no real pinch. There even is some likelihood of developing substitutes on a basis which will make their production in this country permanent.

Hundreds of drug plants which have been imported can be grown here, including the castor oil bean, ginger, orris root, citronella, henna, and ergot. Cheaper labor and more intensive habits of cultivation were the principal reasons for the importation of such supplies from Europe and the Orient.

7 Alkaloids are converted into belladonna products, including apropine sulphate pills being made with this machine

During the World War, when the interruption of world traffic was far less severe, attempts were made to grow drug supplies in the United States. Digitalis, catnip, wormwood, calamus, and orris root were produced by a drug farm near Richmond, Va., starting with 1916, but when the stimulated demand caused by the war had subsided, the cultivation of everything except digitalis was dropped. Digitalis still is being raised with great success.

The present emergency is more exacting, but the research which was done a quarter of a century ago is proving valuable now. The Department of Agriculture has a great deal of information available on the subject and drug manufacturers are in a position to give advice and supervision.

The whole enterprise, however, is on an entirely different basis from the gardens of simples of the past and the naive faith of the herbalists, one of whom wrote in the 16th century "The roots of Solomon's seale, stamped while fresh and greene, and applied taketh away in one night, or two at the most any bruise, black or blew spots gotten by fals or womens wilfulnesse, in stumbling upon their hasty husbands fists, or such."

8 Among the finished products are the tincture, fluid extract, powdered extract, solid extract, Rabellon tablets, atropine sulphate, hypodermic tablets

Hatching the *Ugly*

America's Wartime Yards Turn Out Sturdy 10,000-Ton Cargo Vessels at Unbelievable Pace by Using Standardized Plans and Vastly Quickened Assembly-Line Methods

By J. H. WALKER

WARTIME America is carrying out the hugest program of ship construction in world history, with a current program of 23,000,000 tons of new shipping for 1942 and 1943, and an excellent chance that this goal may be boosted by another 5,000,000 tons or more.

The nation's shipbuilding capacity already has been expanded more than 500 per cent since 1940, and one new yard has built and delivered a complete 10,000-ton freighter in 83 days, substantially under the par of 105 days established by the Maritime Commission. Henry J. Kaiser, West Coast industrialist who had never built a ship until last year, expects to turn out 9,000,000 tons of shipping in his own yards next year, and his construction teams are aiming at an ultimate record of 40 days to a ship.

That is an almost incredible goal, for in spite of recent developments in assembly-line methods and prefabricated construction, the building of ships remains one of the most complex and highly skilled crafts developed by man.

Most people realize that vast sums are being spent and something pretty close to an industrial miracle is being performed to keep our war effort afloat. Yet few know how a ship actually grows from the time it is planned until it enters service.

Ships may vary infinitely in size, design, and detail, but they all have three things in common. They must have buoyancy (be able to float), stability (stay upright and in balance), and strength (withstand strains of the sea and their own weight). And all ships may be classified as either warships or merchant ships. There is no fundamental difference between the two, but the building of large warships is tremendously complicated by the special equipment—armor slabs, big guns, and power and communication lines—which must be crammed into the hull. The basic art of shipbuilding can be more clearly explained in terms of ordinary commercial vessels.

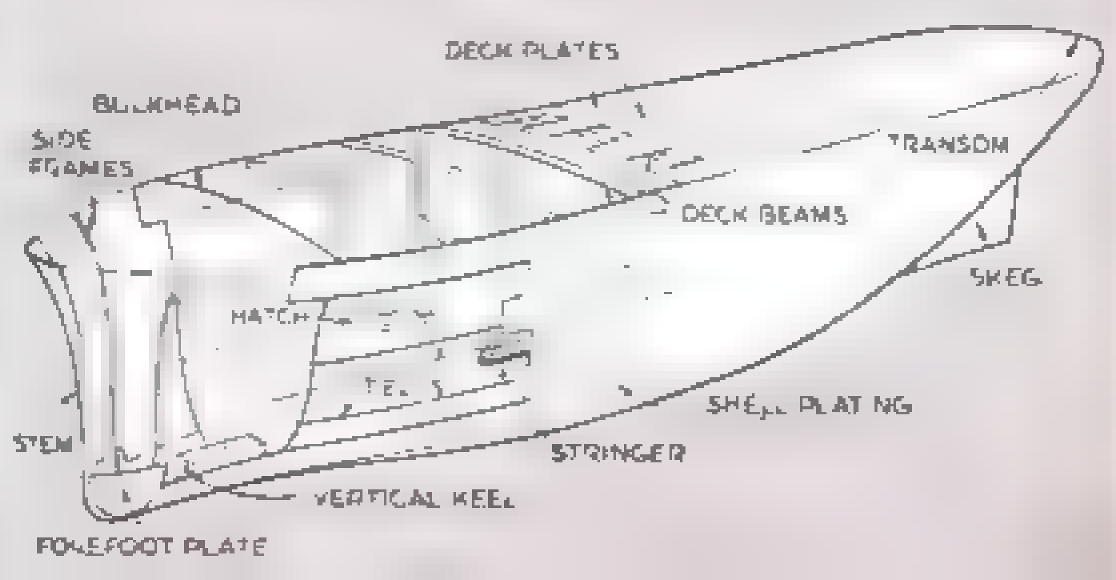
Any ship starts as a plan. The men who do the original planning are called naval architects, and their job—viewed as a problem in construction engineering—is to dream an involved mechanical creature with features of a steel warehouse, storage tank, steam power plant, and highway bridge, then make these factors hook up harmoniously in a limited space, float on water, and propel itself. All this planning, moreover, is influenced by an almost endless list of governing circumstances such as where the ship is going (deep-water harbors or up shallow tropical rivers), what it is to carry (oil, bananas, automobiles, passengers, or any combination), and its speed. The specifications for a small freighter would fill a big dictionary, but that is tiny compared with the 35 or 40 tons of plans and blueprints required for a new battleship.

Unless our ship is to use a hull design of known performance and efficiency, a model will have to be built and tested in a miniature basin to see how it slips through the water. Then detailed plans are drawn of all

What It Takes to Build the Hull of a Liberty Ship

3,200 tons of steel plates, beams, bars, angles, and channels
55,000 rivets
194,000 linear feet of welding

World War I's Ugly Ducklings used 900,000 rivets. Increased use of welding has cut the number to 55,000, which means 1,690,000 less rivet holes to be drilled for World War II's Liberty boats.



Ducklings

the parts, and these plans are taken to one of the most important departments of the shipyard, the mold loft.

This is a long, open room where the plans are reproduced on the floor, and from these drawings full-size patterns of every important structural part are made in wood or paper. The patterns or templates, in their commonest form, are flat strips of wood, trimmed and tacked together to show the exact size and shape of the corresponding pieces of steel.

The next step is the fabrication of metal parts. The main materials used are steel castings, forgings, plates, and shapes. Castings are made by pouring molten steel into molds. Forgings are hammered or pressed out from red-hot metal. Plates are pieces of flat-rolled steel of various thicknesses riveted or welded together to form the outer shell and decks. Shapes are bars, beams, and girders which form the skeleton. All these are cut, punched, bent, or drilled according to the templates, and then fleaded in a steady stream to the storage yard and the slipway where the ship will come into being.

Another Liberty ship slides down the ways at a West Coast yard Henry J. Kaiser, West Coast industrialist, hopes ultimately to attain a record of not more than 40 days for completing a ship

Before actual building even begins, the yard must plan to get the ship into the water when launching time comes. The slipway on which the building is done is usually an open concrete strip running to the water's edge in a gentle slope—less than an inch to a foot grade. Along the center line are placed heavy wooden slabs, called keel blocks, which support the keel, a row of plates constituting the ship's spine.

After the keel has been put in place, the frames, which are the ship's ribs, begin to go up, serving as support and stiffening for the outer shell of the hull. In customary shipbuilding practice, a deck is built of flat steel plates about three or four feet above the bottom of the hull. This is called the inner bottom, and the space between it and the shell is used as a storage space for fuel oil or water ballast.

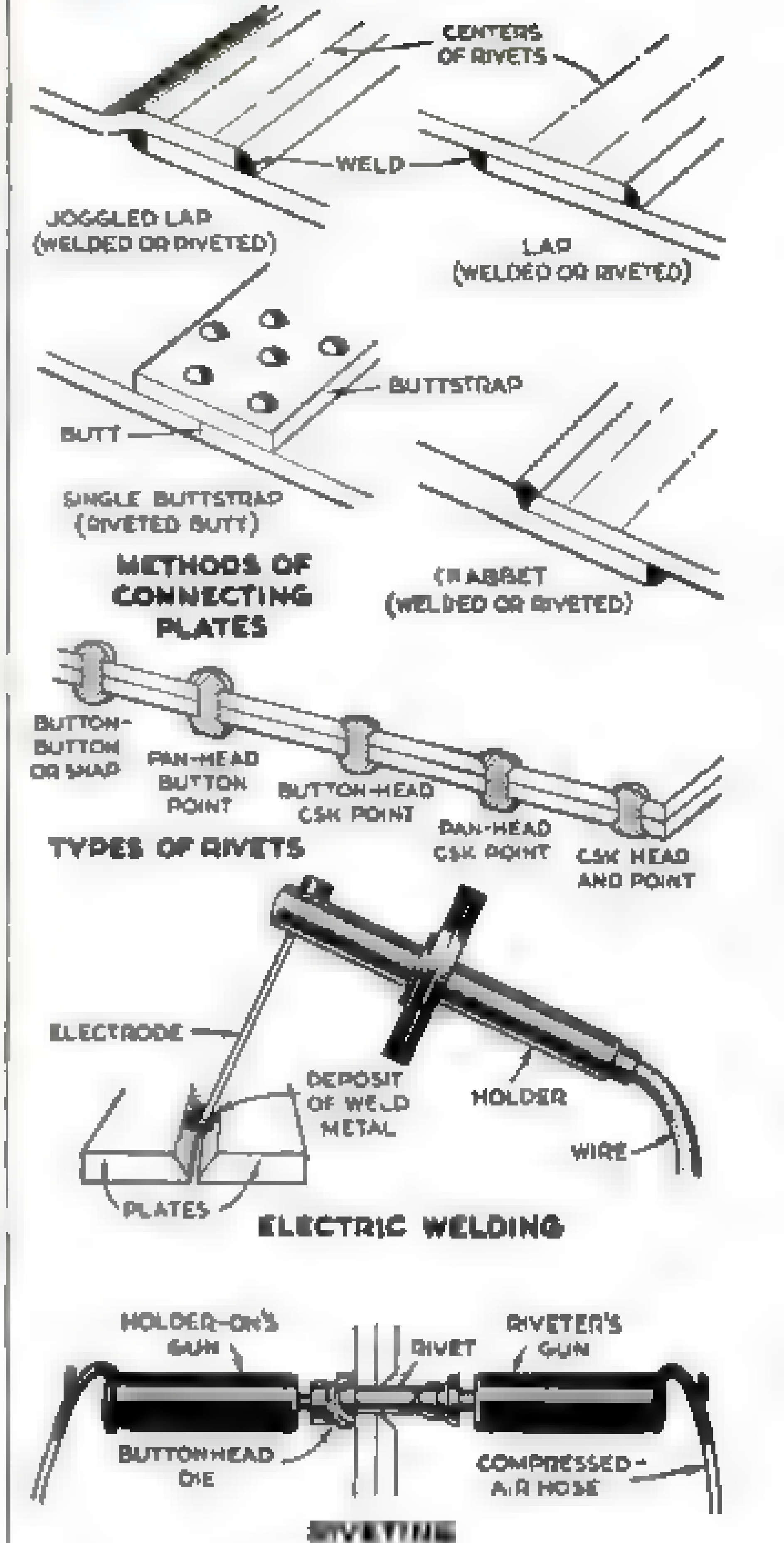
Inside the hull a ship is divided into a number of compartments, separated from each other by large steel partitions called bulkheads. The bulkheads, made of plates and supporting beams, may be solid or pierced by doors which can be closed automatically and made watertight. Thus if a ship is injured or develops a leak, the bulkheads are counted on to confine the damage to one compartment and keep the vessel afloat. Compartmentation has been carried to a particularly fine development in war vessels, which may be hit in two or three sections and still remain afloat and full of fight.

Construction work in a shipyard is traditionally divided into a number of skilled crafts, of which the main divisions are the erectors, shipfitters, reamers and drillers, riveters and welders, burners, and chippers and calkers.

Erectors have the task of getting the steel

PREFABRICATION is the secret of our great shipbuilding success. The tremendous plant building above six miles inland from the East Coast once turned out railroad cars. Now it is turning out the prefabricated parts for Liberty ships. Below three workmen are shaping a section of a ship's stem. Whole bulkheads, deckhouses, and parts of hulls are made up, saving days formerly needed to fit plates

WELDING torches flare throughout this prefabrication shop's 15 acres. Welding cuts down on time, steel, and weight, and its seams are equally as strong or stronger than riveted joints. A comparison is shown at the right



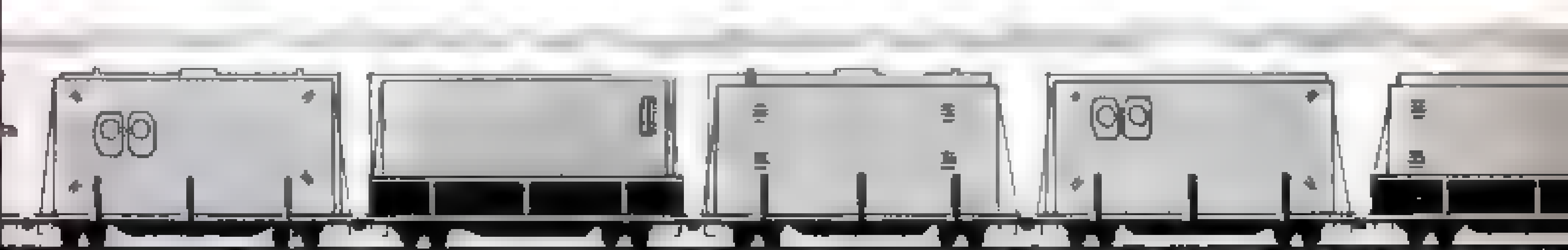
parts and subassemblies on the shipway when they are needed, and hoisting them into place; shipfitters must fit the parts together as required by the plans.

Reamers and drillers prepare the plates and shapes for riveting together. Rivet holes in plates are usually drilled or punched undersize in the fabricating shop, and then enlarged to full size by the reamer's air drill to coincide exactly in plates to be fastened together.

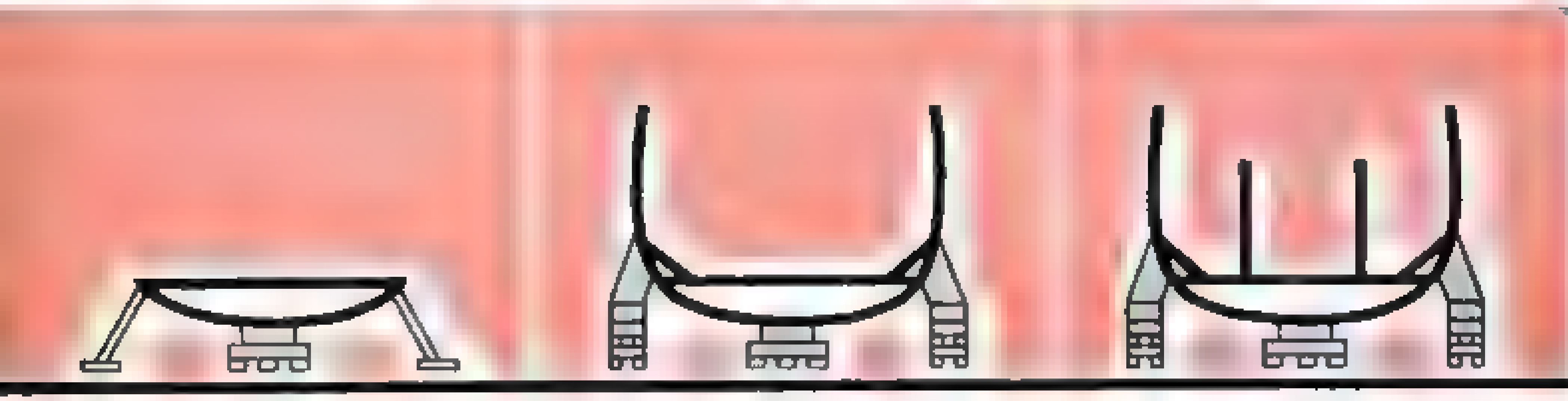
The riveter once was the most characteristic of all shipyard workers; his function has been partly taken over by the welder now, but riveting is still an important shipyard skill. Riveting usually is done by a team of three men, a heater who "cooks" the rivets to the right degree of red heat in a small forge, the "holder-on" who places the rivet and holds it with a compressed-air gun, and the boss riveter, working on the other side of the plate, who uses a similar gun to flatten the protruding end of the rivet and lap it down around the edge of the hole.

The chipper, with an air-driven chisel,

From the prefabrication plant, assembled parts travel by freight car six miles to the shipyard



KEEL AND INNER BOTTOM | RIBS AND PLATES | COMPARTMENTS



cuts away excess metal on any parts going into the ship. He also does the calking, hammering steel together along a seam to make the joint watertight.

The burner, using an oxyacetylene blowtorch, cuts away excess stock that is difficult to chip and cuts holes for ventilator pipes, cables, and doors.

Welding deserves a special word because of the importance it has assumed in the last ten years. Freighters and tankers are taking the water today with barely 55,000 rivets in their hulls, when a few years ago they would have had up to 1,250,000.

A seam properly welded with improved modern technique is as strong or stronger than riveting, is lighter, and presents a smoother surface to the water. The weight-saving factor alone has greatly spread the practice. Aside from these advantages, welding has greatly stimulated prefabrication and helped American shipyards to break all speed records. As much assembly work as possible is now done on sections of the ship before they are moved into the slipway and onto the hull. Whole bulkheads, deckhouses, and bow and stern sections are put together and then hoisted into place by giant cranes. Sections of 75 tons and more are handled in a well-equipped yard.

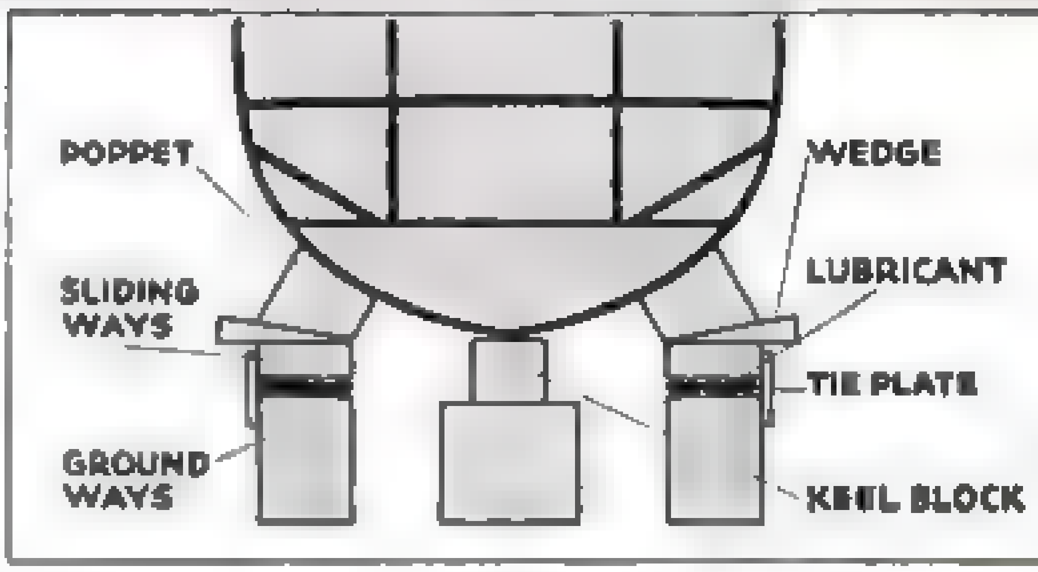
When a ship is ready to be launched, runways of heavy timber are built down to the water; these are the "ground ways." Another set of timbers—the "sliding ways"—is placed on top and built up to the sides of the ship with blocks. A heavy coating of grease and tallow is placed between the two sets of ways. On launching day the blocks of the sliding ways are wedged up to take the weight of the ship off the keel blocks and wooden shores which have braced the

AT THE SHIPYARD the prefabricated parts, lifted from flatcars and hoisted into place, grow day by day into a completed freighter

THE STEPS IN THE BUILDING OF A LIBERTY SHIP

hull on the sides. Steel tie plates which have held the ship back are then burned through, and the big hull, slowly gathering speed, slides down to the water

The ship is still unfinished, however, and is towed to a fitting-out basin, where it acquires its main engines, auxiliary machinery, piping, living facilities, and various gadgets. In peacetime some of this work may be done before launching; in war, a yard launches a ship at the earliest possible moment, clearing the way for another keel.



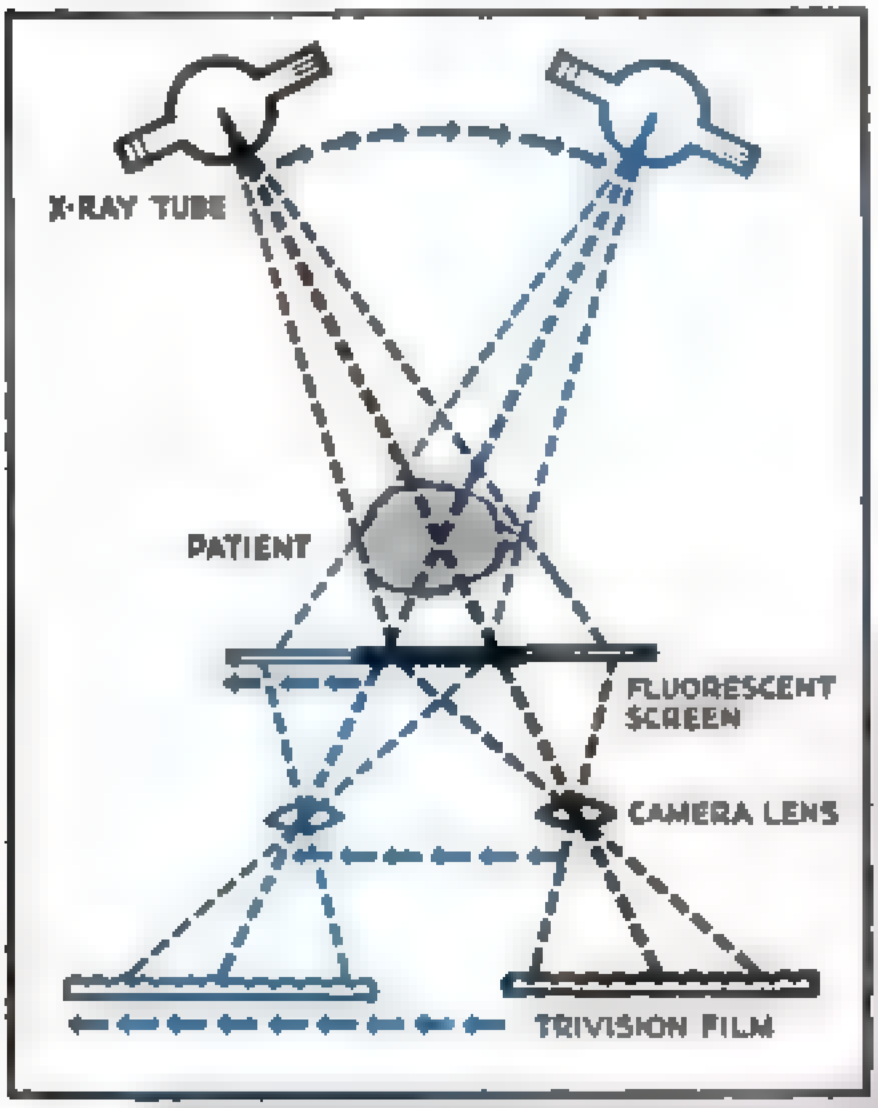
KEEL AND BOTTOM *rise quickly with the parts that flow in to the ways on the rails shown below*

LAUNCHING *is accomplished by driving in wedges to lift the ship from blocks supporting the keel*

Tridimensional

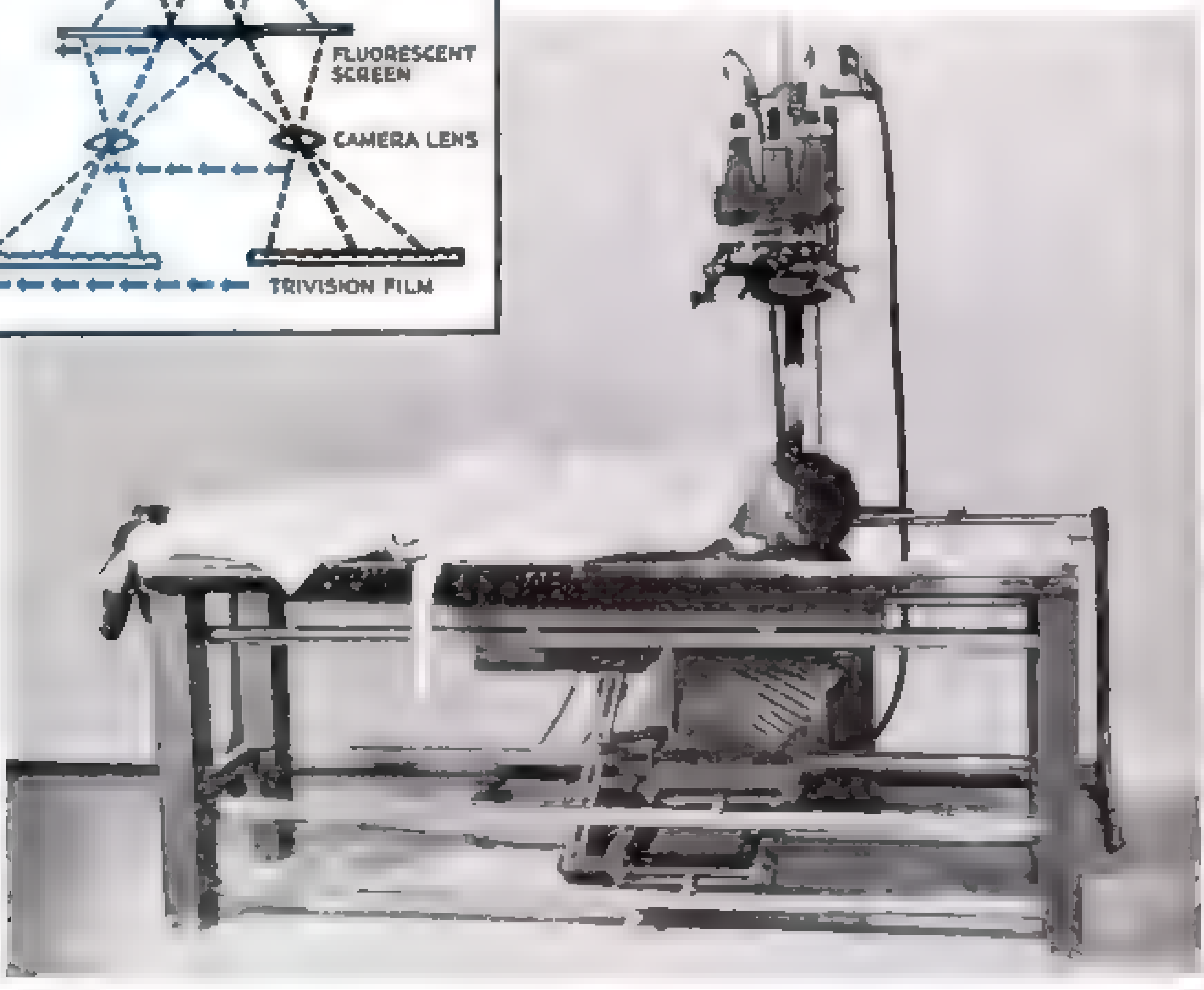
FOURTEEN years ago Douglas F. Winnek of Mt. Vernon, N. Y., started experimenting with three-dimensional photographs as a hobby. Recently he has developed a tridimensional X-ray apparatus which actually makes it possible for surgeons quickly and accurately to determine the length, breadth, and depth of an object with a single radiograph.

This revolutionary new technique, known as Trivision X-Ray, completely eliminates the use of complicated stereoscopic X-ray photography. The secret of Trivision lies in the use of a specially prepared film which is embossed with microscopically small ridges, 200 to the inch. Each tiny ridge acts as a perfect lens which focuses light rays from a given object on a critical point on the film emulsion as shown in the illustration. By scanning the subject laterally with the camera, the point of focus on the film is changed to record a panoramic series of picture elements—one for each ridge—which appear to resolve into undistorted panoramic glimpses of the photographed object.



In natural vision, a person perceives depth in an object because each eye sees the subject from a slightly different angle. Trivision films give the same effect because the pictured side contains a series of views which give each eye a different angle of the

HOW A TRIDIMENSIONAL



X-Ray on a Single Film

object. Consequently an observer can look around and beyond each plane in the picture and get the same effect that he would if he were seeing the object directly.

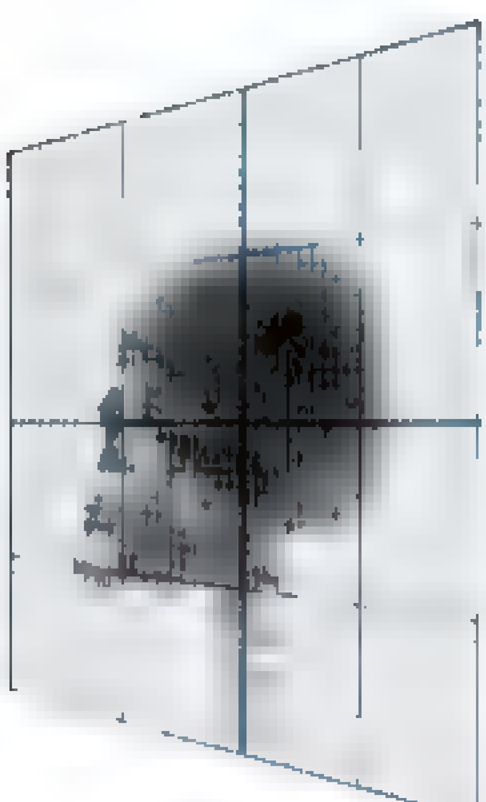
Trivision radiographs are made by photographing a three-dimensional picture of an object recorded on a fluorescent screen. As shown in the first illustration, the X-ray tube, fluorescent screen, lens, and Trivision film are all mounted on an axis which pivots around the subject to be X-rayed. By keeping the screen, lens, and film moving in parallel planes, the image recorded on the fluoroscope is kept in perfect focus.

In operation, the patient is placed on a table with the portion of his body to be X-rayed placed directly over the fluorescent screen. As the current is applied to the X-ray tube, the tube stand pivots around the target, supplying radiations at various angles. At the same time the camera assembly—below the fluorescent screen—scans on a parallel plane and makes a three-dimensional picture of the subject recorded on the fluoroscope.

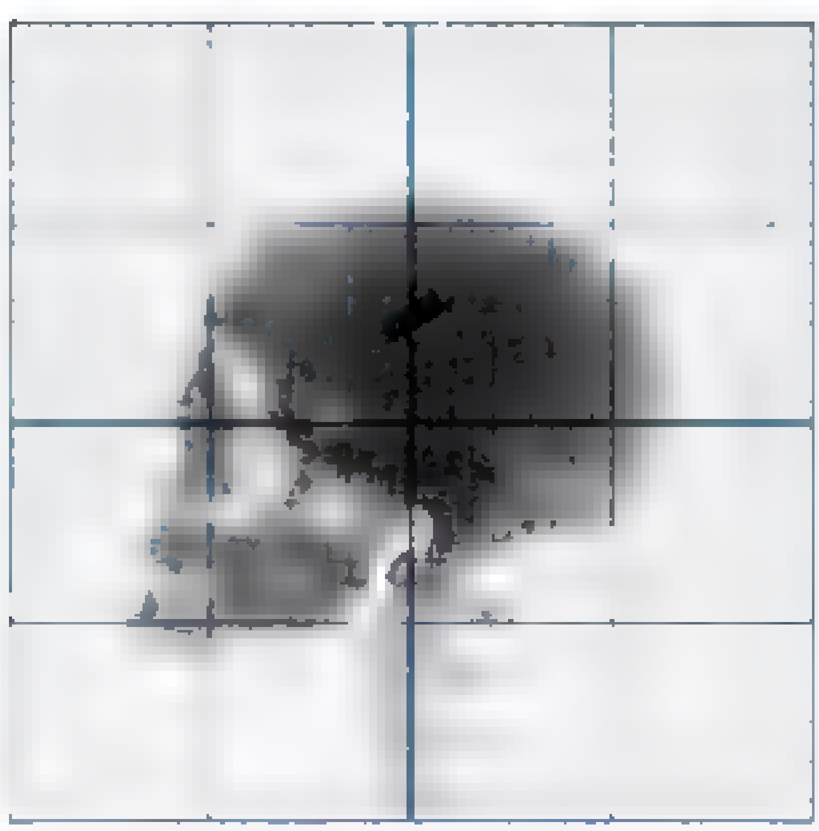
When a foreign object must be removed by surgery, it is of utmost importance that doctors know exactly where and how deep the object lies before they can operate. By using the Trivision technique, a surgeon can take an X-ray film, place it behind a special measuring grid, and determine—to the millimeter—just where he will have to probe to remove the object.

Measuring depth with the Trivision grid is accomplished by turning the film between two extreme panoramic views as illustrated. By counting the number of millimeters on each side of the plane at which the grid appears to be superimposed, it is possible to calculate the depth of the object. When the X-ray film is an enlargement or a reduction of the natural size of the object, the grid reading is determined by multiplying the

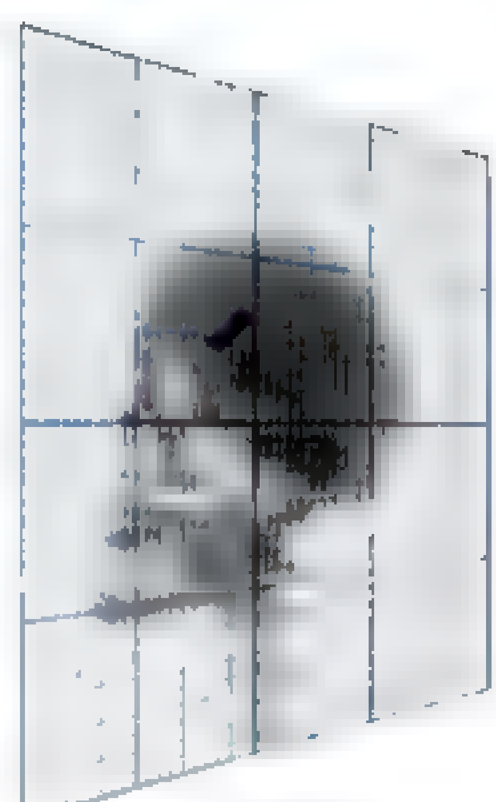
X-RAY IS MADE, AND HOW THE SURGEON USES IT



TURNED TO LEFT

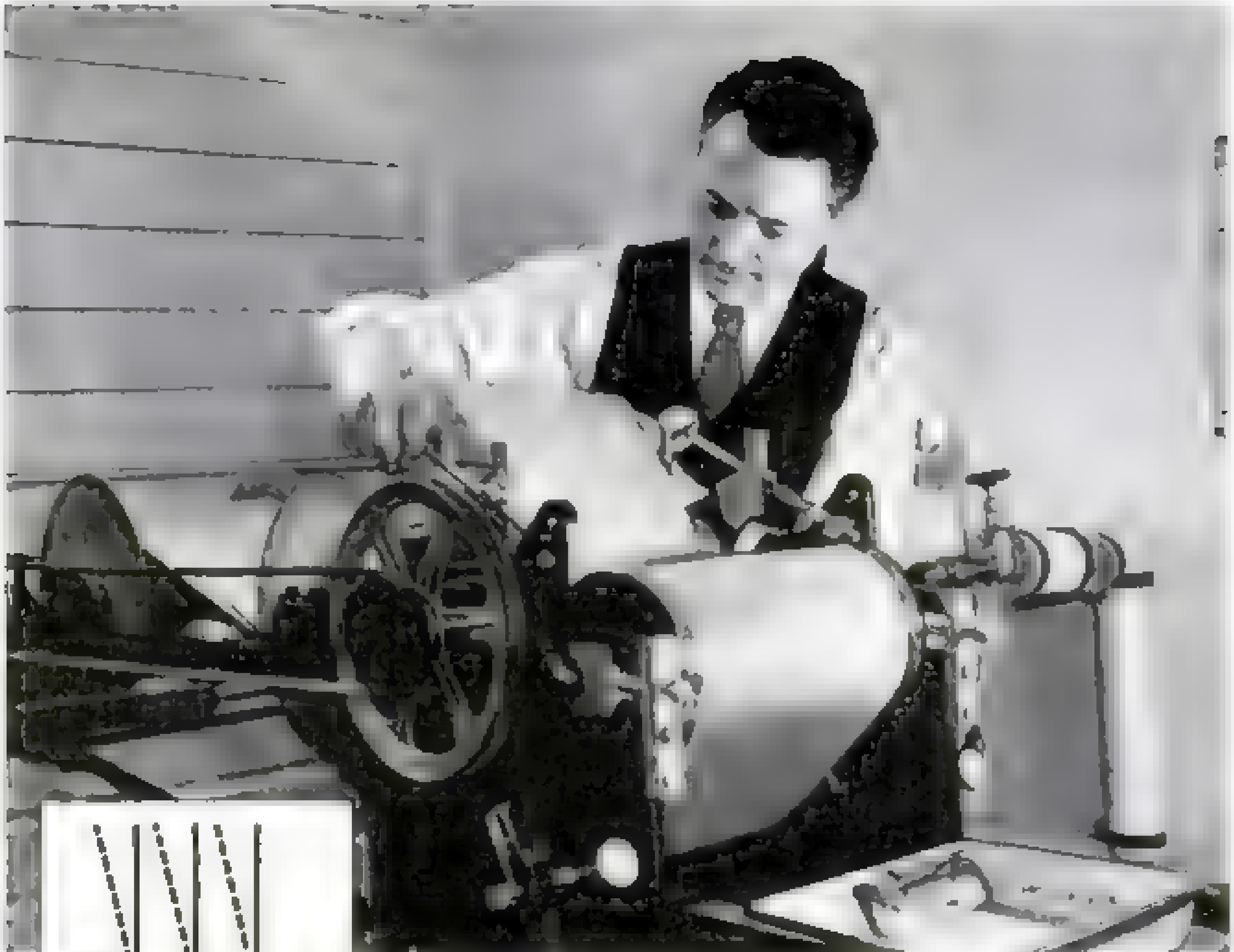


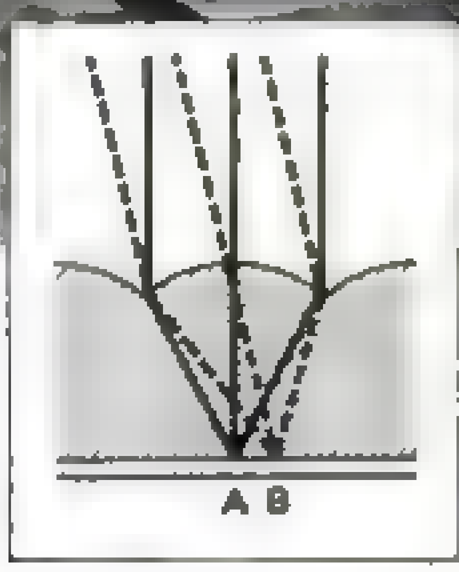
FRONT VIEW



TURNED TO RIGHT

Principle of the three-dimensional X-ray is illustrated in the drawing on the opposite page. Moving in an arc, the X-ray tube scans the subject, which is placed above a fluorescent screen. Below the screen, the camera moves, recording the panoramic series of views on special film embossed with microscopic ridges. In the apparatus seen in the photograph at left, the screen, camera, and film holder are mounted on separate trays, each riding on a pair of rails. All three trays are inclosed in a light-tight bellows. To use a Trivision X-ray photograph in locating a foreign object in the body, the surgeon places a measuring grid in front of the emulsion side of the film. When the film is turned as pictured above, measurement of the displacement of the object on the grid gives an exact guide to its location.





TRIDIMENSIONAL FILM is prepared with this machine. Unexposed film is fed through a series of rollers, one of which embosses it with tiny ridges, 200 to the inch. For black-and-white film, the embossing roller is heated to soften the film; for color film, this is done by a chemical solvent. Inset shows a highly magnified section of film. Each ridge acts as a lens catching light rays at different angles as tube and camera move

grid count by the magnification or reduction factor.

Not only does Trivision record three-dimensional X-rays, but it also has the added feature of recording motion on a single film. This phenomenon is due to the fact that Trivision film records the successive changes in an image during the time of exposure. Consequently, when the film is moved slowly from one side to the other, the eye quickly picks up each individual image recorded while the camera scanned the moving object. In taking a radiograph of the heart, for example, the exposure of the camera is long enough to record the expansion and contraction of the heart muscle. When the film is viewed, the heart can be observed at any position of its action cycle by simply moving the film at an appropriate angle.

If a surgeon wants to study a complete cycle of heart action in slow motion, he can use a stroboscopic apparatus which produces X-radiation at desired intervals. These intervals are timed so that the film will record just one cycle of heart action instead of two or three.

Although Trivision is still a baby not quite two years old, its inventor has, in addition to the X-ray, developed a three-dimensional studio camera and a clinical camera that are attracting wide attention. Winnek also has invented a Trivision aerial camera, but its details are a military secret.

Not satisfied with transparent films, Winnek is now working out a method of reproducing Trivision on positive paper which will make possible three-dimensional photographs suitable for framing. Applications of the idea to portrait photography, preparation of display material, and other uses suggest themselves almost without limit. Further development of cameras, film, and reproduction methods can be expected.

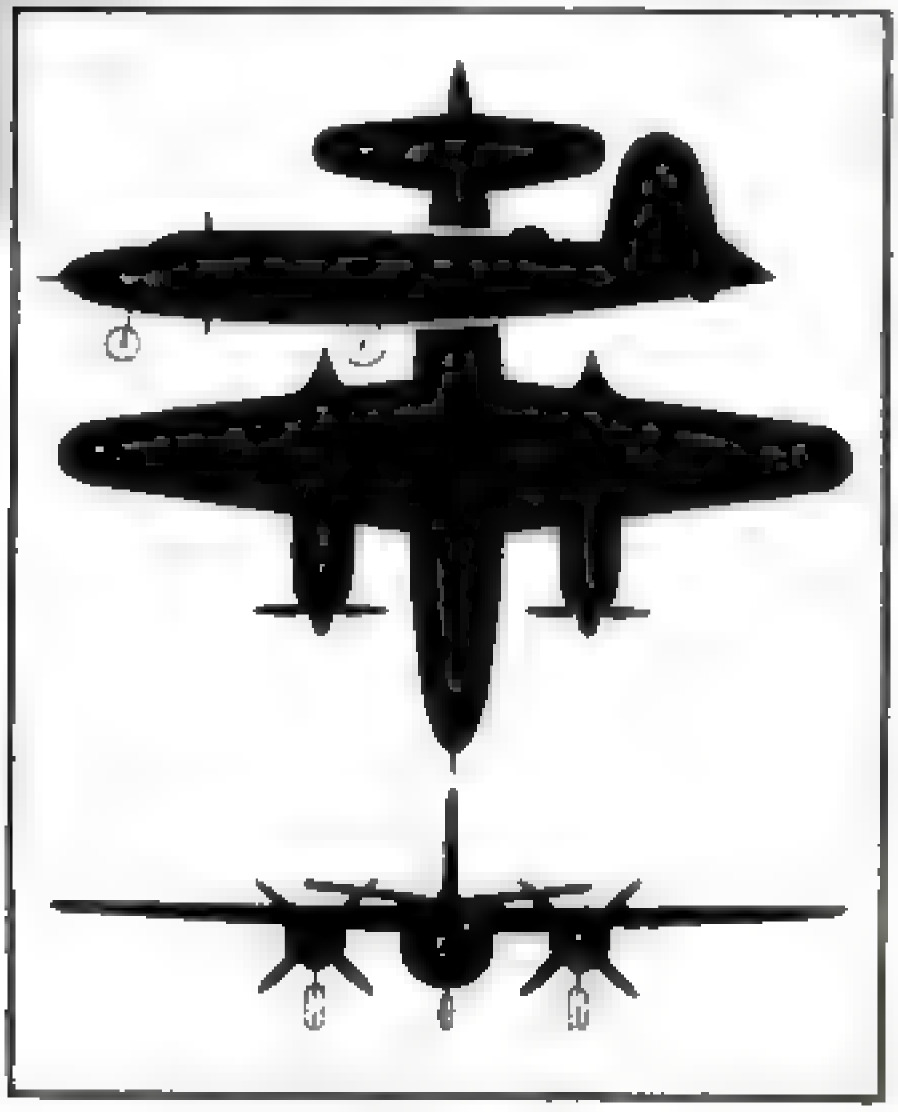
Below is our artist's conception of a U. S. Army land-based B-26 plane dropping a torpedo like a bomb upon the deck of an enemy aircraft carrier. On the far side of the vessel, a white wake and an explosion show where torpedoes have been launched at the vessel by other attacking torpedo planes

Our New Torpedo Bombers to Batter the Axis

Quickly Mastering a New Weapon, the U. S. Army and Navy Make It Even More Formidable by Using Improved Planes and Adapting Craft of Other Types to the Job

ABOUT 25 new aircraft carriers—half a million tons of floating plane bases, to be exact—will boost the U. S. Navy's air power, in a huge expansion program, just authorized by Congress in addition to the mighty two-ocean fleet now building. Construction of superdreadnoughts not yet laid down will be postponed in favor of the urgently needed carriers.

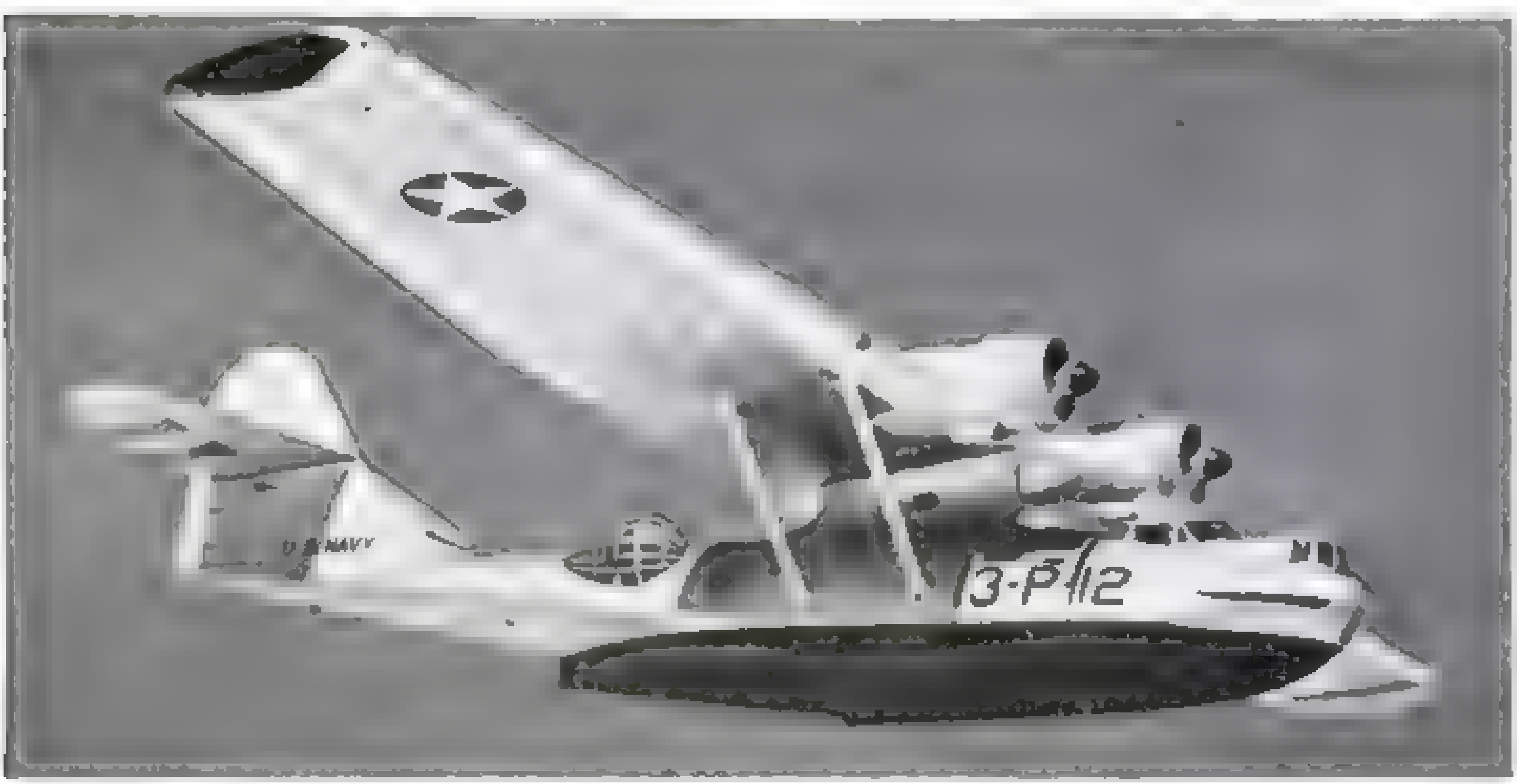
Powerful new torpedo planes, now recog-



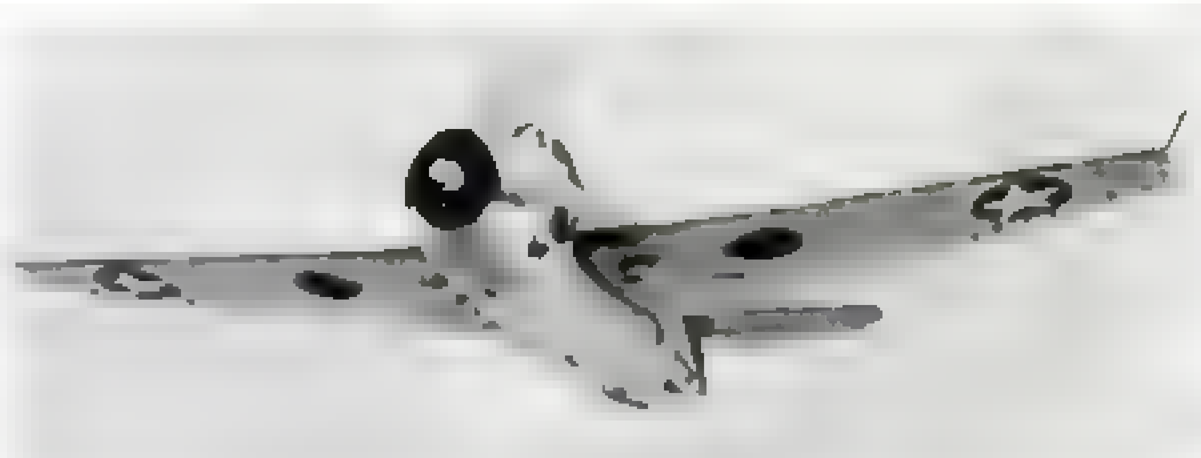
B-26 Army planes of this type, already famous as bombers, have proved successful as torpedo carriers. Sketches at the left show side, top, and head-on appearance of these speedy, twin-engined craft

nized as rivals of battleships in sea power, have brought about this outstanding change in our naval policy. Bombers, important as they are to a well-balanced land or naval force, have sent to the bottom during the present war only one capital ship—the 27-year-old Japanese battleship *Haruna*. Over the same period, torpedo planes have participated in sinking at least four capital ships, including two of the latest and most formidable.

One of these, the fast 35,000-ton German battleship *Bismarck*, had almost



PBY Another surprise in recent air-naval actions was the appearance of coast-based patrol bombers like this in the role of flying torpedo tubes. The big flying boats have long cruising range



GRUMMAN AVENGER

Newest of the Navy's carrier-based torpedo craft carries a full-size 21-inch torpedo, completely inclosed in its belly to reduce wind drag and conceal its mission. It has a speed of more than 270 miles an hour and a cruising range of 1,400 miles. Note the guns forward, aft, and under tail

made good its escape from the British home fleet when torpedo aircraft overtook it and smashed its steering gear. It was wallowing in circles when surface ships arrived and finished it. In turn, a combined attack by Japanese torpedo planes and bombers put a swift end to Britain's pride, the new 35,000-ton battleship *Prince of Wales*, and to the older British battle cruiser *Repulse*. Torpedoes are believed to have caused the mortal damage to both ships, and also to the U. S. battleship *Arizona* at Pearl Harbor.

Named after that attack, Grumman-built Avengers, newest of U. S. torpedo planes, arrived at Midway Island late last spring—just in time to destroy carriers and other major ships of a powerful invasion fleet.

Experts call the Avenger the deadliest torpedo plane in the world today. Powered by a motor of 2,000 horsepower, it cruises at more than 270 miles an hour, about 50 miles an hour faster than previous types. One of the largest of carrier-based ships, it carries a 2,000-lb. torpedo of 21-inch diameter, the same size used by submarines and destroyers. After being mounted in place, the missile is completely inclosed by swinging covers. This offers a double advantage. The machine is completely streamlined for speed. Moreover, though enemy spotters will quickly learn to recognize the plane, they will still be kept guessing as to what kind of attack to expect, since the doors can conceal either the one-ton torpedo or an equal weight of air bombs. Heavily gunned, the three-place craft is well equipped to fight back at aerial attackers.

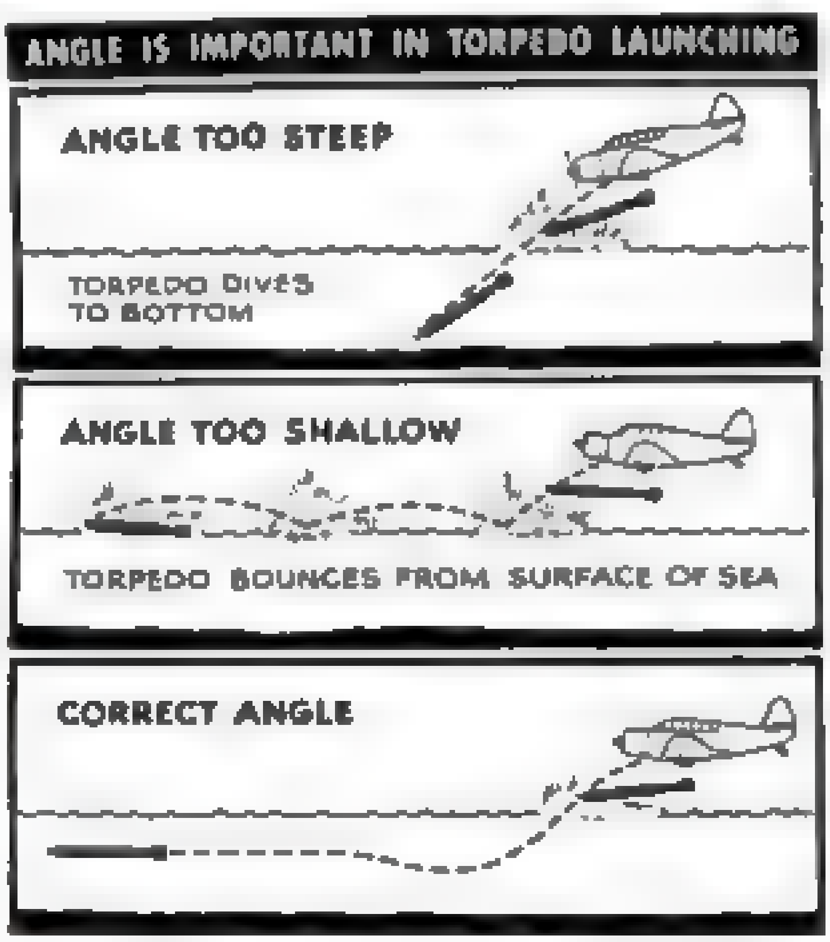
Until the arrival of the Avenger, the Douglas Devastator, or TBD, has been the Navy's choice of torpedo bombers based on carriers. Likewise a single-motored, three-place craft, the Devastator has given a good account of itself in battle. First modern torpedo monoplane, it also can launch armor-piercing bombs, in an attack upon an enemy hundreds of miles at sea.

For long-distance missions, the Navy uses its shore-based PBY's, big flying boats with a range of thousands of miles. Formerly they have been exclusively "patrol bombers," as their code symbol designates them.

The Army now has its torpedo planes, too. Martin B-26 bombers have been successfully converted for torpedo attacks in offshore operations against hostile warships.

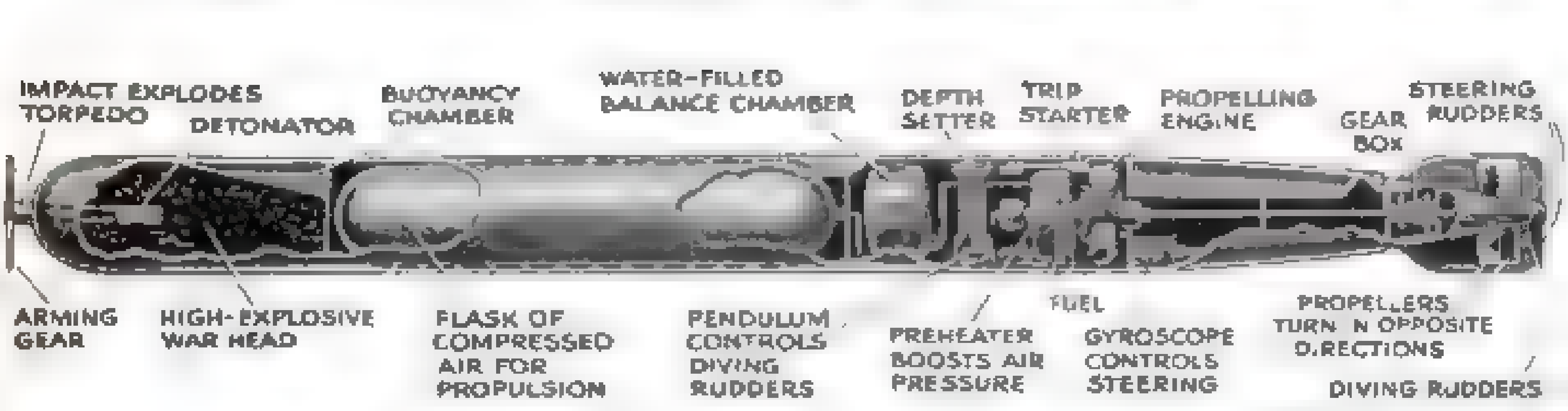
Although torpedo planes were invented by an American—the late Rear Admiral Bradley A. Fiske—Great Britain was the first to build and use them. In 1915, during the previous war, a British lieutenant sank four Turkish ships in the Sea of Marmora with 730-pound Whitehead torpedoes dropped from his plane. Today all modern air forces employ torpedo planes.

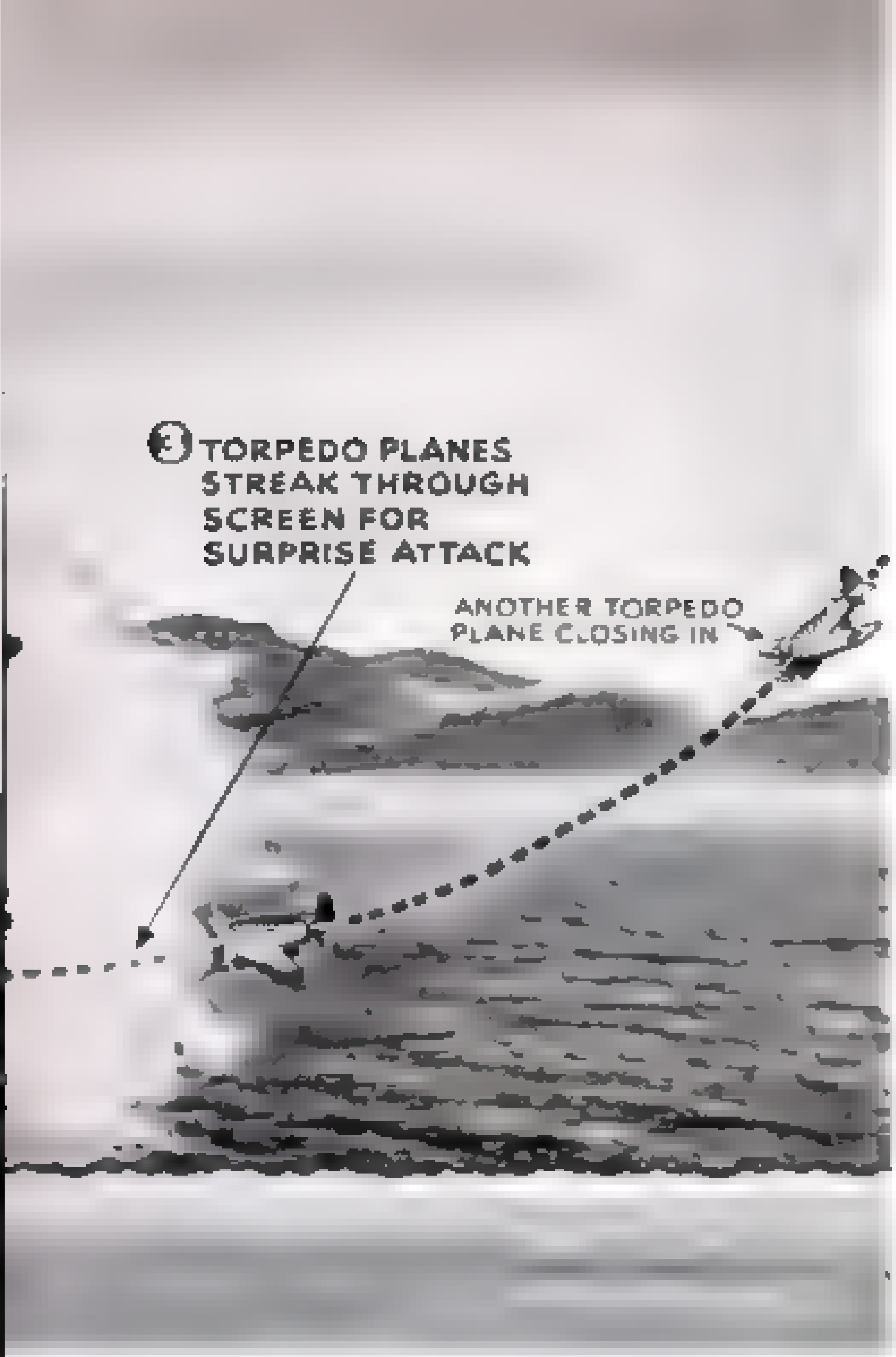
That does not mean the "death knell of the battleship," as some calamity howlers would maintain. As long as other nations

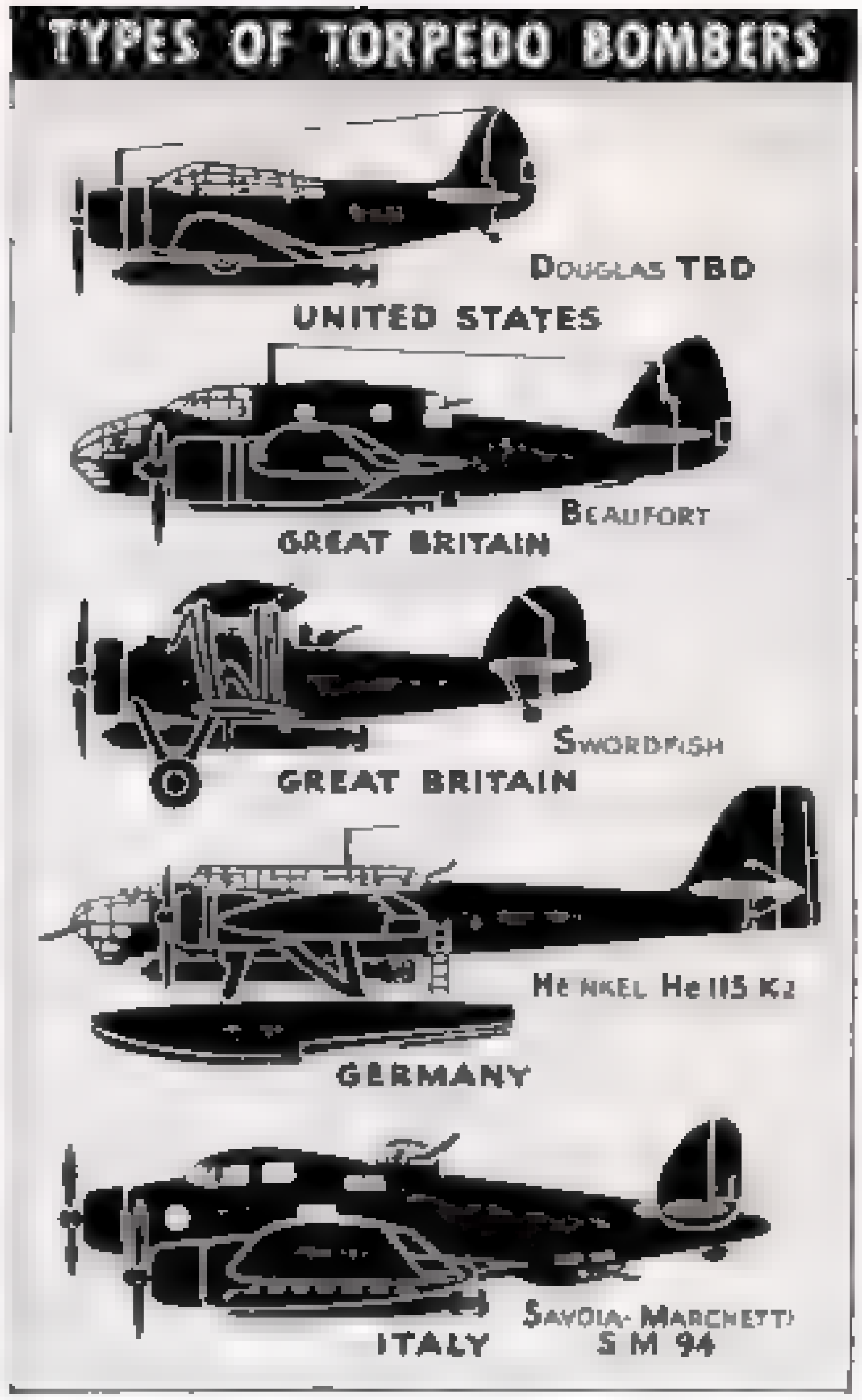


How torpedo planes attack a battleship. In the new technique, supporting horizontal and dive bombers draw off the fire of the attacked vessel while fast planes lay smoke screens. Plunging through the smoke, the torpedo planes can approach to short range before being subjected to gunfire and the equal danger from fountains of water thrown up by shells. Drawing at left shows how angle of launching determines effectiveness of the torpedo; below, how the pendulum functions. At the bottom of the page is a cut-away of a Whitehead torpedo

Drawings by STEWART ROUSE



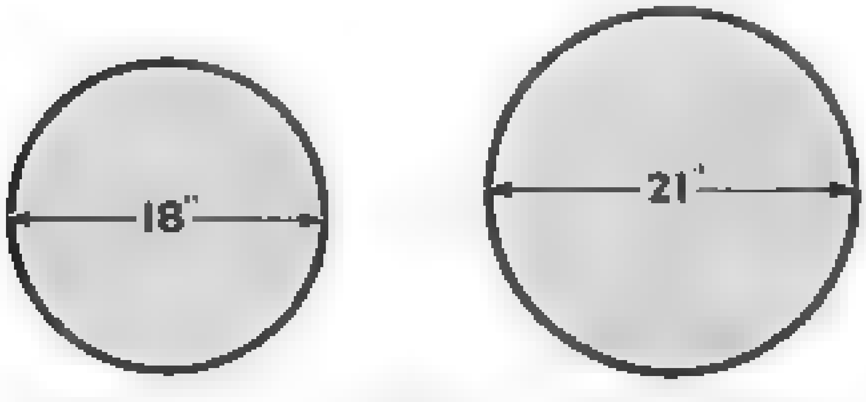




Belligerent countries show wide range of tastes in their torpedo planes. The U. S. Navy prefers a carrier-borne type; Germany likes the seaplane type

have them, so must we. For the mission of battleships, in modern naval tactics, is to fight other battleships. Likewise we have already seen the spectacle of aircraft carriers, through their planes, fighting other aircraft carriers. But the torpedo plane's missions are far more numerous. Any craft upon the sea may be its target. Still another possible use was suggested by an incident that occured in Italy some time ago.

Torpedo-plane pilots of the R.A.F. are reported to have dropped their projectiles in a lake created by a hydroelectric plant, headed toward the dam. Results of this



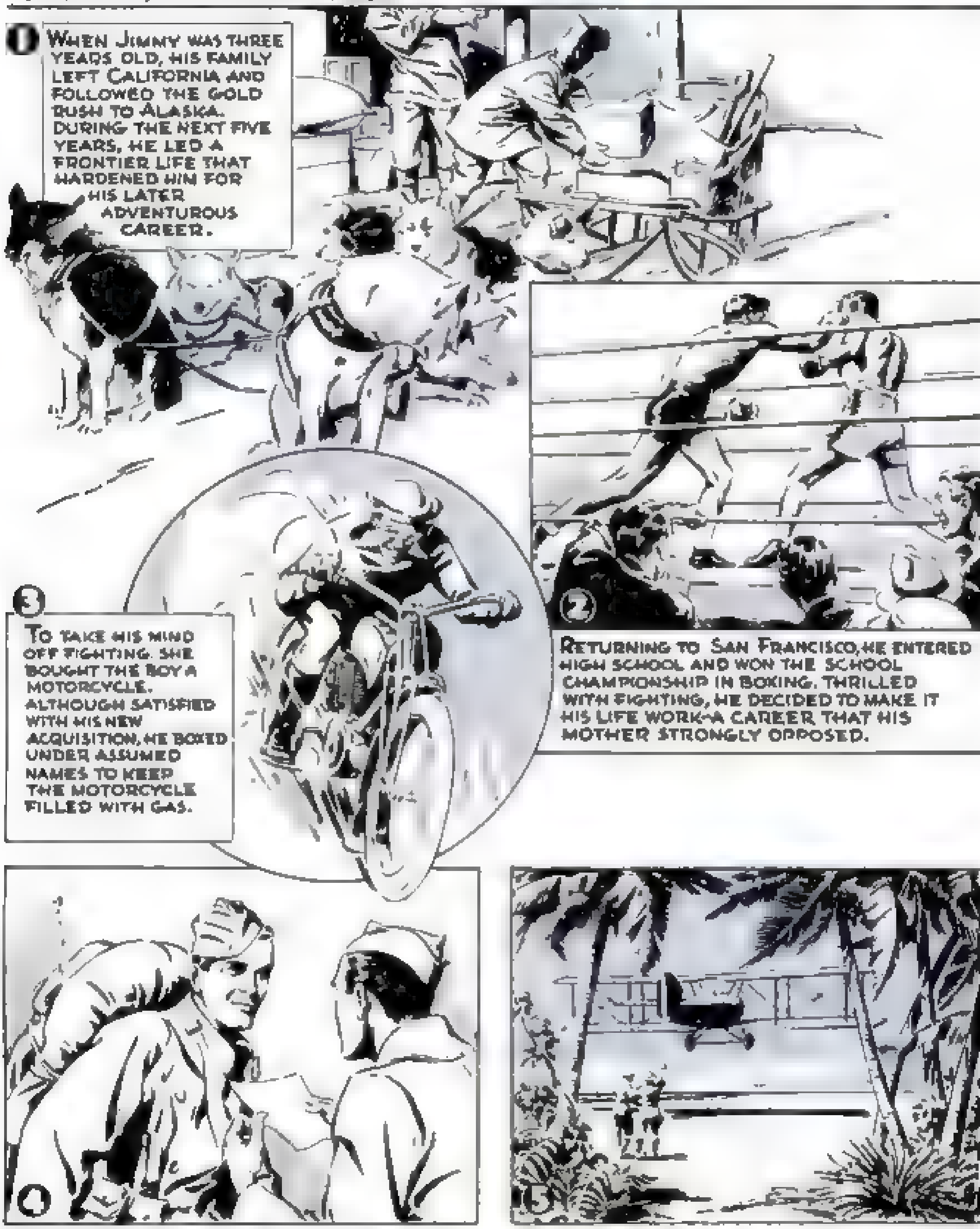
Most planes use torpedoes of 18-inch diameter, compared with the 21-inchers that are standard for destroyers and subs. Weight is the important factor

"experiment," if such it was, have never been made public. But even if a massive concrete wall resisted the explosion of a torpedo, as it probably would, the possibility of wrecking a dam's spillway gates, or of putting ship-canal lock gates out of commission, offers considerable food for thought.

In attacking a warship, a standard procedure for torpedo planes requires them to skim the water, drop the "tin fish" as near as possible to the target—perhaps as close as 200 yards—and then wheel away. Meanwhile the torpedo, continuing on an underwater path, strikes the vessel broadside. In his approach, the pilot faces all the gunfire that can be trained on him, and also the risk of fatal collision with columns of water thrown aloft as shells fall into the sea. But if he succeeds in hitting a big ship, he does so at its most vulnerable point, below the belt armor that resists low-angle shells, and the deck armor that protects it from air bombs and high-angle shells. A smoke screen enables him to emerge at an unexpected spot or angle. In addition, he has a good chance of making a surprise attack if horizontal and dive bombers create a diversion meanwhile.

Here's My Story

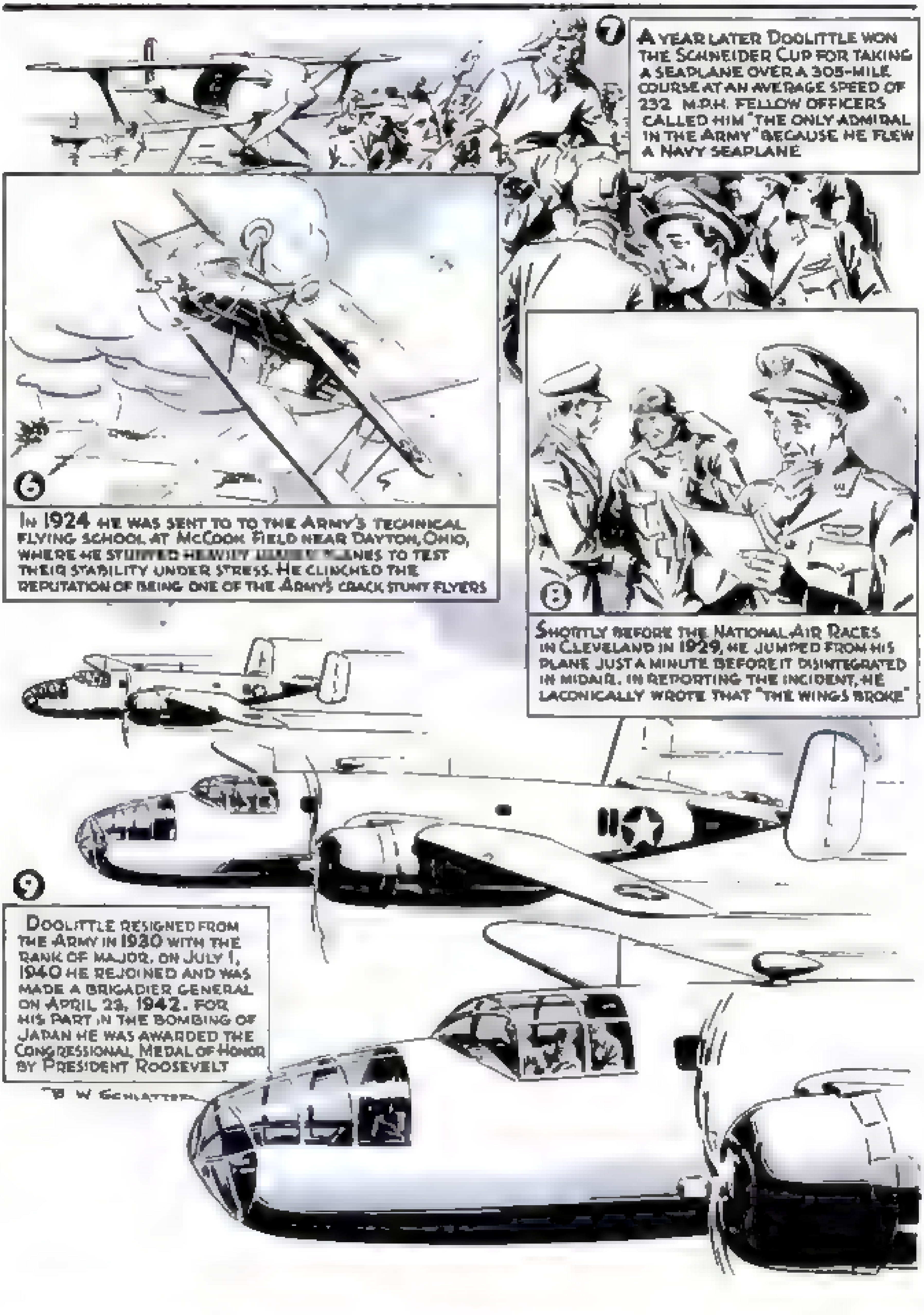
BRIG. GEN. JAMES H. DOOLITTLE, LEADER OF THE FIRST AIR RAID ON JAPAN, WAS BORN IN ALAMEDA, CALIFORNIA, ON DECEMBER 14, 1896



WHEN THE LAST WAR BROKE, JIMMY DROPPED HIS STUDIES AT THE UNIVERSITY OF CALIFORNIA AND JOINED THE ARMY SIGNAL CORPS AVIATION SECTION. TWICE HE WAS ON THE VERGE OF GOING OVERSEAS BUT EACH TIME THE ORDER WAS RESCINDED—THE SECOND TIME JUST AS HE SET FOOT ON A HOBOKEN PIER

DOOLITTLE WAS COMMISSIONED A LIEUTENANT IN 1920. IN SEPTEMBER 1922 HE MADE A RECORD-BREAKING FLIGHT BETWEEN PABLO BEACH, FLA., AND SAN DIEGO, CALIF., IN 22 HOURS AND 30 MINUTES. FOR THIS HE WAS AWARDED THE DISTINGUISHED FLYING CROSS

THE CAREER OF
BRIG. GEN. JAMES H. DOOLITTLE



Disney frequently consults Navy representatives on ways to combine live action and cartoons. He confers above with Lieut. J. C. Hutchison on planes. Below a studio artist smashes the swastika, one of his many war campaign drawings

MICKEY MOUSE AND DONALD DUCK WORK FOR VICTORY

MICKEY MOUSE and Donald Duck have gone to war. Through Walt Disney and the artists who draw them, Mickey and Donald and their fanciful pals are making movies designed to instruct soldiers and sailors in the proper handling of their weapons, and to teach civilians how to combat disease, improve sanitation, and to perform other functions contributing to the war effort.

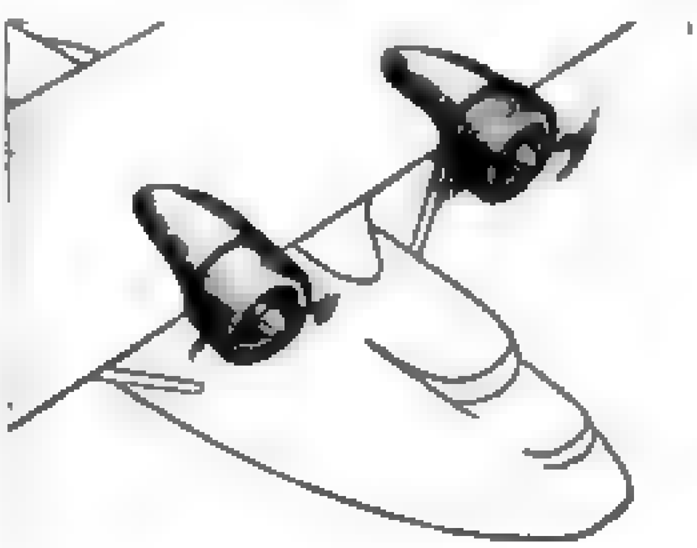
Some of the military films are so confidential that only members of the armed forces may see them. These pictures, and others which are to be publicly shown, represent visual education in its most easily assimilable form. They are simple but dramatic. For example, the Disney studios have just completed a picture called "Immunization," which presents a powerful argument in favor of vaccination. In this film the human body is represented as a city inhabited by vigorous red characters, and disease is shown as a rabble of ugly black bugs. The bugs attack, the defending red soldiers are driven back, and the city seems doomed to destruction. Then a doctor injects healthy organisms into the city, and the reinvigorated red soldiers, riding jeeps and tanks and armed with guns, rout the black bugs and drive them beyond the city's walls.

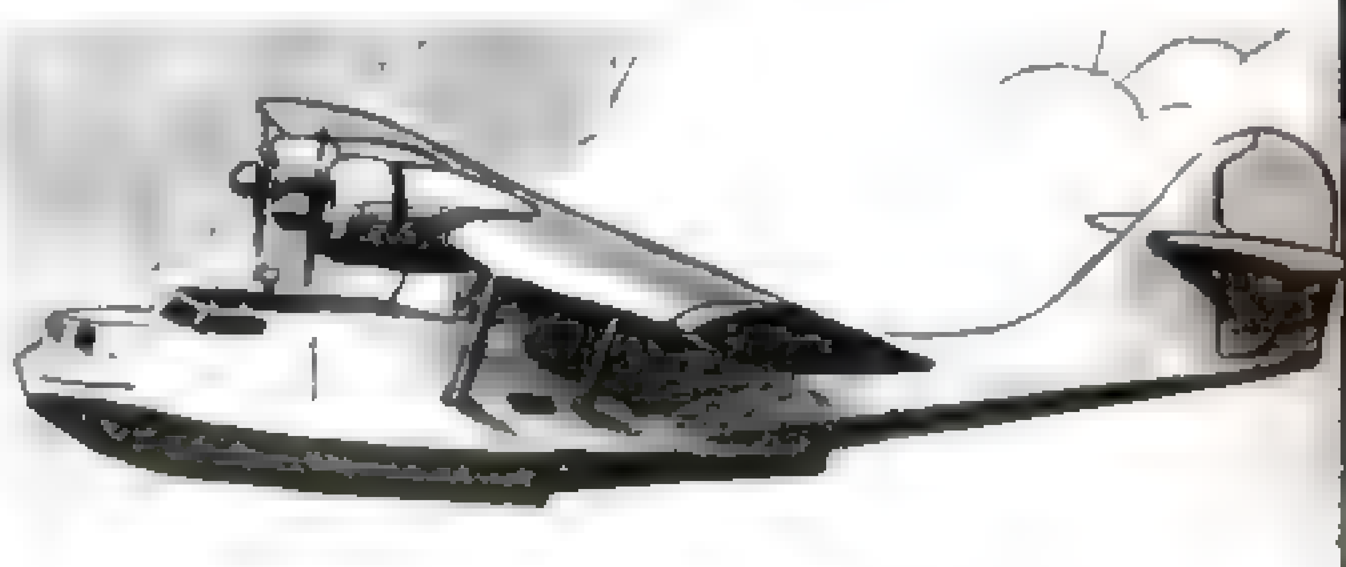
FIGHTING MALARIA WITH THE PEN. In these scenes from a Disney movie on the importance of mosquito eradication, the cartoon villain attacks a human (right), gorges on his contaminated blood (top left), and transfers germs to another victim

A picture intended for the instruction of air-raid wardens, soldiers, and sailors, teaches an audience in 15 minutes how to identify a B-25 bomber. Another service film called "Aerology," a term invented to distinguish the picture from an ordinary meteorological exposition, will be shown over and over again to every pilot in the Army, Navy, and Marine Corps. After seeing it, a flyer should be able to recognize thunderheads, icing conditions, and storms, and extricate himself before disaster overtakes him.

From a third service film gunners are expected to learn more in 20 minutes about the operation of the famous Canadian .55 caliber antitank gun than they could learn in as many hours of individual instruction. It opens with a comedy sequence in which a cartoon rifle is shown blasting tanks coming head on, diagonally, and at right angles across a field. Then the gun is broken down in animated cartoons and the operation of each part, from the recoil reducer to the mechanism for ejecting cartridge cases, is shown in detail. In conclusion, an Army sergeant repeats every part of the lesson in live action with a real gun.

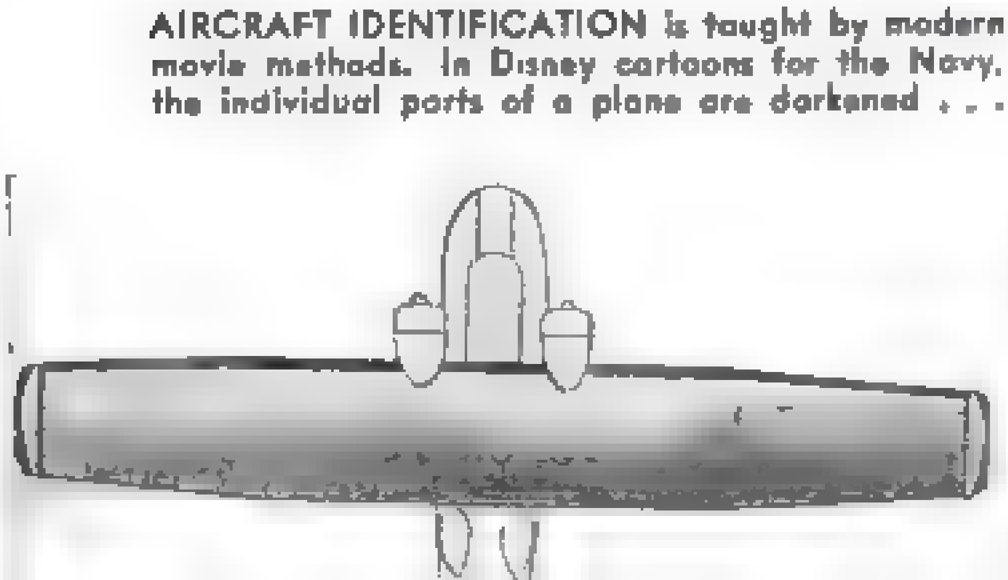
Although the military and naval films are increasing in quantity, the bulk of the Disney production is still aimed at selling the United States to Latin America, raising the standard of living and health there, and demonstrating how Pan-Americans can develop their own natural resources.

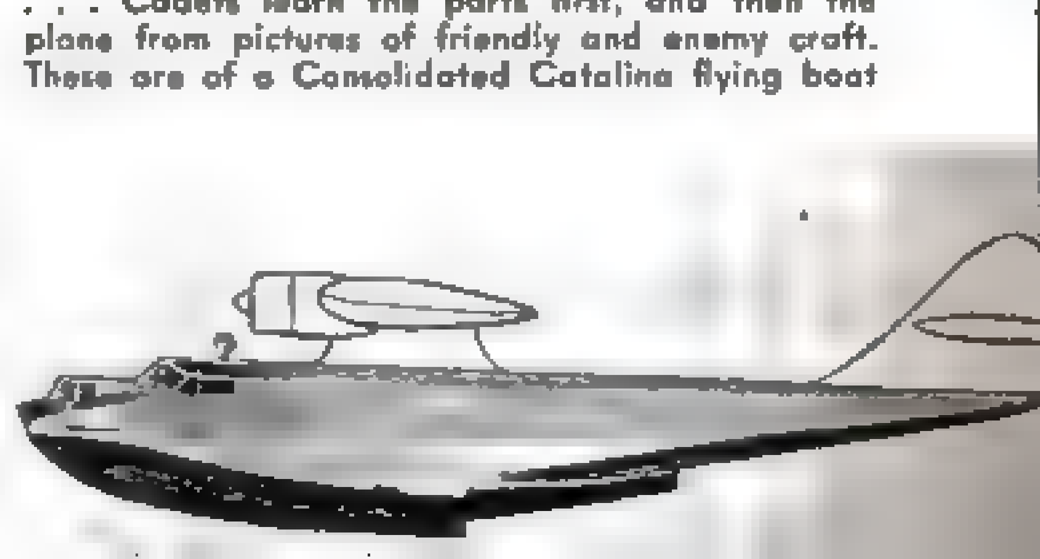




AIRCRAFT IDENTIFICATION is taught by modern movie methods. In Disney cartoons for the Navy, the individual parts of a plane are darkened . . .

. . . Cadets learn the parts first, and then the plane from pictures of friendly and enemy craft. These are of a Consolidated Catalina flying boat



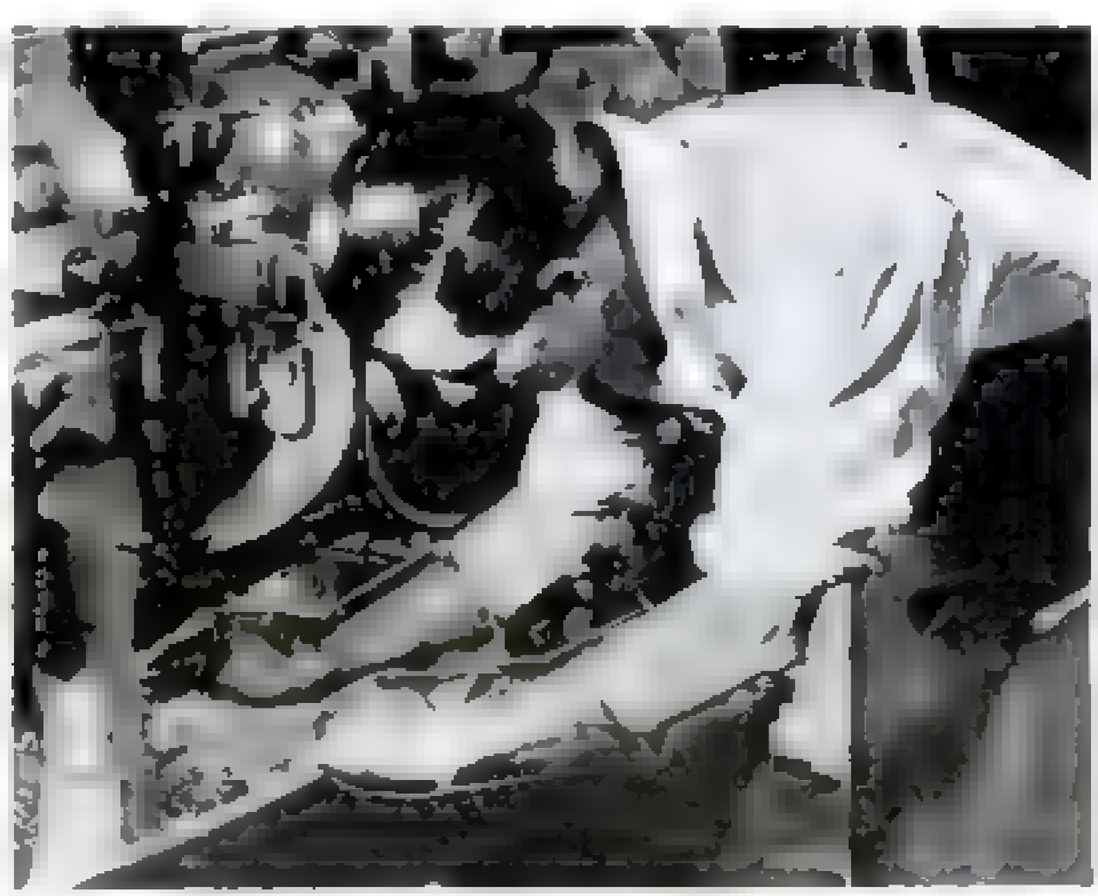


Trailer Gasses Weeds for Planting Trees in Reforestration

This tractor-towed machine injects chloropicrin gas to kill weeds in soil for raising tree seedlings

CHLOROPICRIN, a poison gas whose sweetish odor resembles that of fly-paper, has found a new job. In the last war it served as a man-killer, or in lesser concentrations as tear gas. Now, masked workers have applied it in a 40-acre "tree factory" to replant burned forests of Oregon and Washington. After the gas machine killed weeds in the soil, nurserymen planted enough seed for 10,000,000 trees, including Douglas fir, Port Orford cedar, Sitka spruce, and western hemlock. Next December, men will walk behind a harvesting machine, gathering five-inch-tall seedlings in baskets.

Aprons, Gloves Guard Workers Against Oil



HEAVY-DUTY pretreated aprons, called immune to all oils and oil solvents, now are available for a wide variety of industrial operations. According to the maker, the material retains its flexibility, so as not to hamper a worker, despite its protective coating. Gloves of the same material, also illustrated at right, can be furnished. Both apron and gloves safeguard a worker against skin infections caused by exposure to the sulphur-base cutting oils used in metal-working industries, and to numerous toxic solvents.

Fighter's Trail Is Sky Pretzel

SPECTATORS puzzled when an experimental version of the speedy Lockheed P-38 plane, being test-flown at high altitude, left a pretzel-shaped trail of white behind it. Was the pilot skywriting a secret message? Or was he tracing his course for ground observers with theodolites? Col C. A. Shoop, operations officer at the Lockheed factory, dispelled the mystery. Air, compressed in passing through the supercharger and motor, expanded on release from the exhaust. If you depress the valve of an auto tire to let some air out, you can observe the cooling effect caused by such expansion. Coupled with the low temperature and pressure of the upper air, the effect was pronounced enough to freeze the moisture in the exhaust vapors and leave a trail of ice particles! Striking photographs that have been made of high-altitude air combats over England have shown the same phenomenon on many occasions.


A supercharged plane motor left this trail of condensed ice crystals

Store-Window Dim-Out Leaves Merchandise Well Displayed

ILLUMINATED show windows that look practically as bright as ever, yet provide a real "dim-out," have been worked out by the Consolidated Edison Company of New York. Since the company does not intend to patent the idea, any store is free to use it. The secret is simply a screen of black cotton netting, hung from a roller just behind the glass. Light meters show that the screen reduces the light by 75 percent.


BEFORE. This is the way the camera caught a bright store-window display. Note sidewalk and edge glare

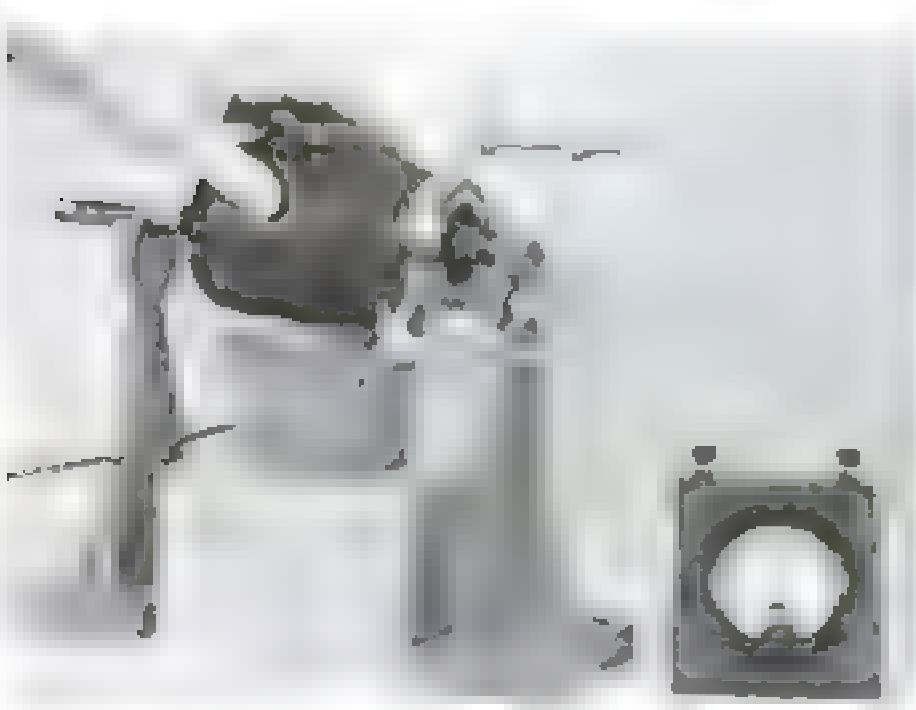

AFTER. Though 75 per cent of light is dimmed out by screen, camera shows light on display is still good

new Tools

QUICKLY CLEANING WELDED AREAS of slag, scale, and oxidation, particularly in hard-to-get-at inside corners, a new end brush that fits the chuck of all standard power tools is shown below. It was designed particularly to speed weld-cleaning operations in wartime production and is said to be much faster than chipping and scraping.

A HORIZONTAL GRINDER that makes short work of resurfacing the cylinder heads of gasoline engines, or of their motor-block tops, manifold flanges, and other flat surfaces, is now incorporated in a handy flat-top table. Designed for precision work, the machine's 11-inch grinding wheel is mounted on a preloaded and lubricated ball-bearing motor shaft. A micrometer control adjusts the grinding-wheel level, and a vacuum-type dust and abrasive remover is standard equipment on the device.

TESTING ARMATURES of small motors to locate defective windings is greatly simplified with the device illustrated in use on armatures with both horizontal and vertical commutators, below. The unit consists of a "growler," a heavy wound electromagnet, in the electrical field of which the armature is supported free to turn. With adjustable brushes attached to a low-reading voltmeter, induced current is instantly registered as the armature is turned. Brush ends compress to follow irregular commutators.



The tester set up for use. The armature can be revolved. Good coils will register an induced current

Close-up of a vertical-commutator armature being tested. Note compressible points of brushes

Blackout Mike Glows in Dark

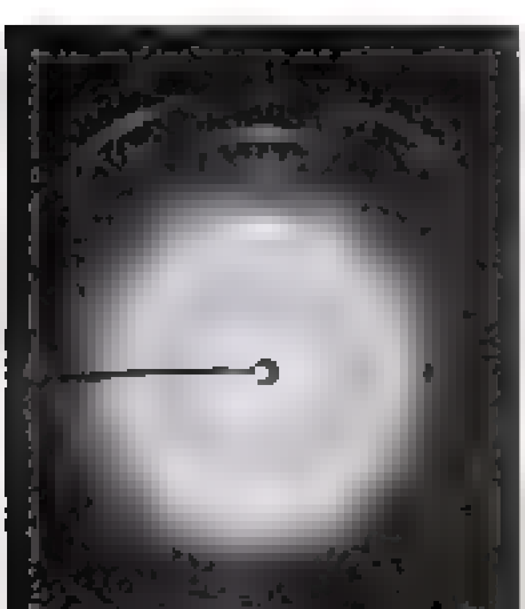
DRAPED in trimmings coated with phosphorescent paint, a radio microphone becomes easy for a studio broadcaster to find in the dark. The paint absorbs light from sunshine or artificial illumination, and gives it off again when the lights go out, according to General Electric engineers who devised the stunt. Another blackout wrinkle demonstrated in the photo at right is the use of fluorescent ink for the script employed by the announcer. When he holds this in an invisible beam of "black light" or ultraviolet light, the letters stand out in a soft glow, visible for only a few feet.

Abroad, both phosphorescent and fluorescent paints have been used to mark air-raid shelters and signs directing persons to them. In this country, recently developed paints of these kinds show much improvement over earlier types. Their use has been recommended within the home, in places such as the edges of stair treads, to prevent accidents through stumbling.

X Ray Shows Structure and Value of Substitute Rubber

X RAYS aid the search for rubber substitutes in a method applied by the U. S. Rubber Company at its Yuma, Ariz., field laboratory. Test samples vulcanized and stretched show a pattern of spots rimming a sphere, as in the X-ray photo in Fig. 1, if they have the crystal-like structure of natural rubber (Fig. 3). One promising plant from Central America, known to botanists as *Forsteronia floribunda*, exhibits this pattern (Fig. 2), as does another, *Cryptostegia grandiflora*, now grown in Florida, California, and Arizona. These yield annual rubber crops, compared to four or five years for a substantial harvest from guayule. That vulcanized rubber from milkweed has comparatively poor properties is indicated by the absence of spots in the photo in Fig. 4.

1 X-ray of good rubber. Dots rim the sphere



2 Native Central American plant meets test

3 Once-common rubber from Far East looks thus

4 Rubber from milkweed lacks required dots

Un-Natural History

BY *Gus Mager*

WHOLE COLONIES OF **CASPIAN TERNS** HAVE BEEN KNOWN TO PLUMMET DOWN ON THEIR EGGS AND PIERCE THEM WITH THEIR BEAKS ON THE APPROACH OF AN INTRUDER! IT IS BELIEVED THAT THEY ARE FOOLISHLY TRYING TO PREVENT THE EGGS FROM BEING STOLEN!

NUMEROUS **COBRAS** THROUGHOUT INDIA, INDO-CHINA, THE MALAY PENINSULA, AND THE PHILIPPINES SHOW SPECTACLE-MARKED HOODS! THESE SINISTER MARKINGS SHOW ONLY WHEN THE COBRA IS EXCITED AND HAS HIS NECK EXPANDED!

OFFENSIVE ODORS GIVEN OFF BY THE **MEXICAN BAT** ARE SO STRONG THAT THEY OFTEN MAKE HUMAN PREMISES UNINHABITABLE! GUANO, THE SUBSTANCE THAT CAUSES THE ODOR, IS SO VALUABLE, HOWEVER, THAT THESE BATS ARE OFTEN WELCOMED AS TENANTS!

WORKER **BEES** DEVELOPED AIR CONDITIONING LONG BEFORE MAN EVER THOUGHT OF THE IDEA! IT IS ONE OF THEIR JOBS TO CIRCULATE FRESH AIR THROUGH THE HIVE BY FANNING WITH THEIR WINGS!

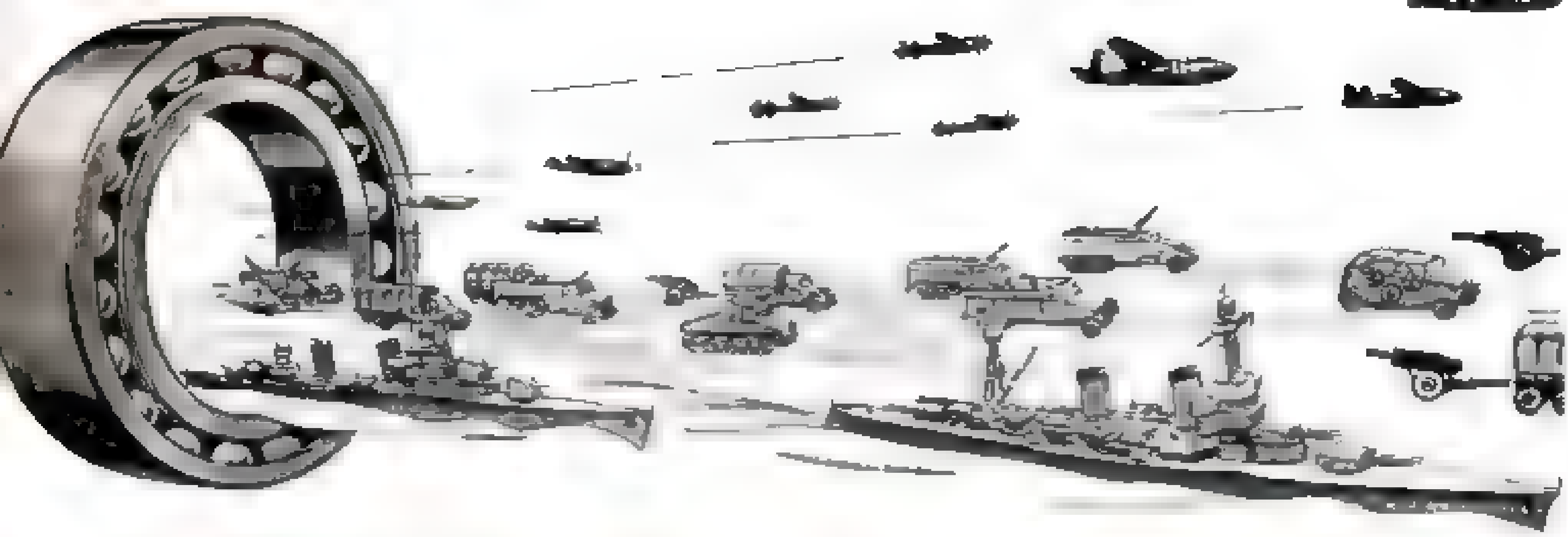
THE **MARINE IGUANA** OF THE GALAPAGOS IS A FORMIDABLE-LOOKING LIZARD THAT ACTUALLY LIVES IN THE WATER! ALTHOUGH HE IS THREE FEET LONG, SCALE-ARMORED AND HAS A ROW OF SHARP TEETH, HE IS JUST AS TAME AS A PUPPY-DOG!

FOR CENTURIES **GINSENG** PLANTS HAVE BEEN ESTEEMED BY THE CHINESE AS THE SOURCE OF A MIRACULOUS CURE-ALL! MODERN MEDICAL RESEARCH, HOWEVER, HAS PROVED THAT IT IS ONLY A MILD AROMATIC STIMULANT!

"Plane" on Car Is Machine-Gun Target

TRAVELING at a lively pace around an oval track, an Army car, carrying a scaled-down plane fuselage above its roof, affords realistic training for machine gunners of the bomber command at Moody Field, Fla. Lest a novice prove more enthusiastic than accurate, a thick earthen wall leaving only the "airplane" exposed keeps him from winging the driver. Track and target are built to a scale permitting a student to fire at equivalent ranges from point-blank to 1,000 yards. Guns swing and tilt like aircraft weapons, and can be brought to bear upon the "enemy" with equal rapidity. The arrangement is suited both for testing aptitude and for mass training. A few trials show whether an aspirant is a "natural-born" gunner, whether he has the qualities that will enable him to learn, or whether he is hopeless.

This Army car takes a scaled-down fuselage around a track to give target practice to the machine gunner below. A dirt wall, at right, shields driver and car



Modern War Rolls Along

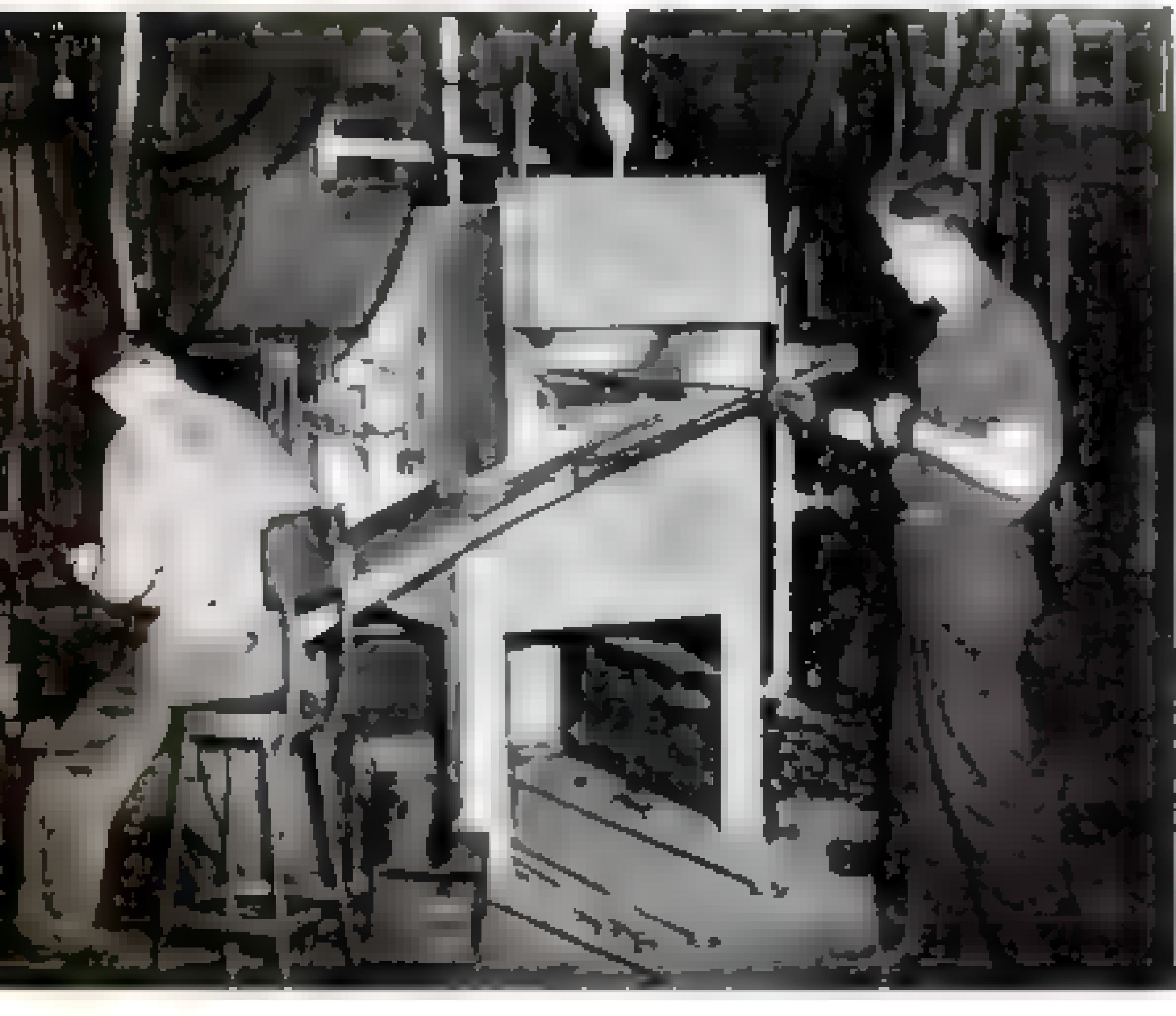
BEARINGS PUT THE SPEED IN OUR MACHINES OF BATTLE

By HERBERT ASBURY

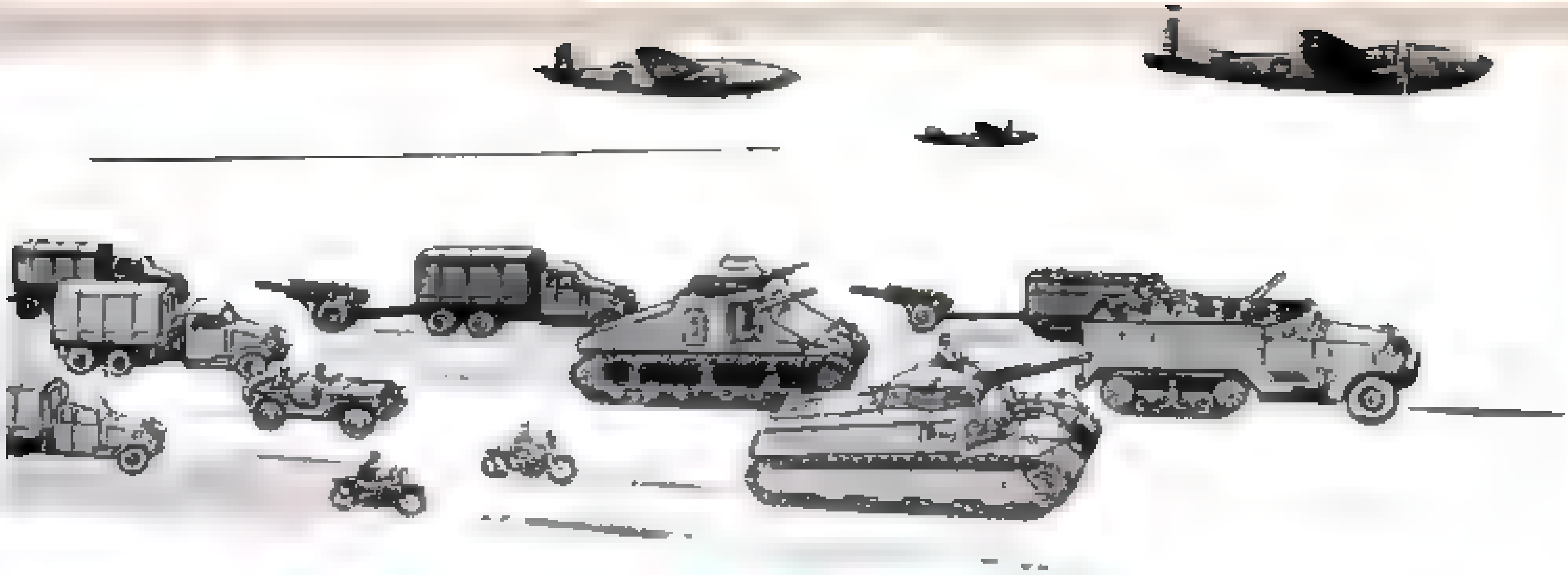
NAPOLEON'S army may have traveled on its stomach, but modern warfare demands a more efficient means of locomotion. The military power of today, highly mechanized and depending upon speed for maximum effectiveness, both travels and fights on ball and roller bearings. If by some unhappy miracle the world's supply of these bearings could be destroyed and the manufacture of replacements prevented, all the smooth-running and delicately balanced machinery of the Army and the Navy would soon come to a grinding halt. Machine tools in our great industrial plants would be troublesome and inefficient; many would be entirely useless.

Mankind learned centuries ago that rolling friction was less than sliding friction, but the ball and roller bearings which represent the greatest advance yet made in the age-old fight against friction are of comparatively recent development. The first extensive practical application of the ball bearing was in the development of the bicycle, the manufacturers of which used a bearing of the cup-and-cone type, so called because the balls rolled between two surfaces shaped like a cup and a cone. It is still regarded as suitable for this and similar applications, but for general purposes

BLANK Beginning of a bearing ball is a small blank sheared off a piece of steel wire or, for balls larger than one inch in diameter, of bar stock. The smaller balls are cold-pressed, but blanks for the larger ones are heated red-hot in furnaces like the one shown



Heated or unheated, depending on their size, blanks are fed into pressing machines in which they are squeezed between pairs of cup-shaped dies. The blank below is ready for pressing



on BALLS OF STEEL

AND OF PRODUCTION—AND HERE'S HOW THEY ARE MADE

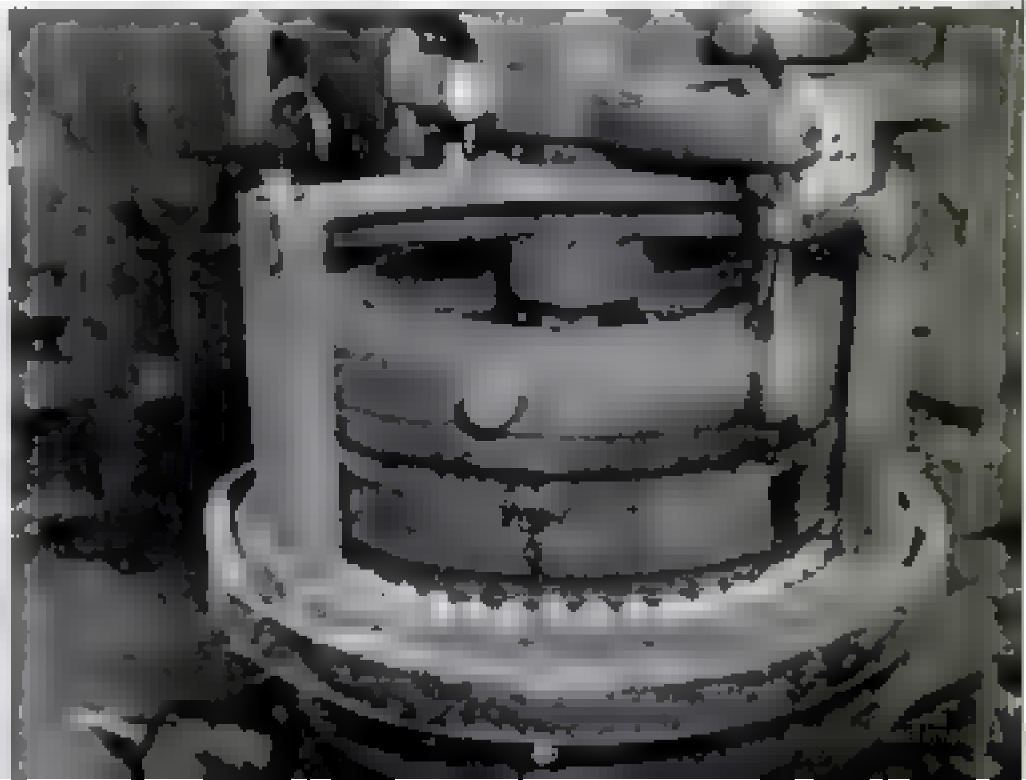
has been superseded by the ring bearing, which was developed about 40 years ago. The first of these bearings used balls only, but the roller bearing followed within a few years. The roller, though running less freely than the ball bearing, will take greater loads, and is favored for use in heavy machinery.

The modern bearing, which plays such a vital role in America's war production, falls into three main classifications—the ball, the cylindrical roller, and the spherical roller. These are subdivided into an extraordinary number of types and sizes. In the catalogs of S K F Industries, one of the world's largest manufacturers of bearings, more than 6,000 are listed, each designed for a particular application. The most recent of these classifications is the spherical roller, which was developed by S K F about 25 years ago. Shaped like a barrel, the spherical roller combined advantageous features of both the ball and the cylindrical roller, having a measure of the former's sphericity and the extensive contact surfaces of the latter.

Ball and cylindrical bearings are made in both the single and double-row type, and some of the double-row balls are made self-aligning, which is accomplished by giving a spherical finish to the inner surface of the outer ring. The balls with which the bearings are loaded range in size from one sixteenth of an inch, outside diameter, to almost seven inches. Other parts of the bearing correspond in size, so that an assembled ball bearing may weigh anywhere from a few ounces to 200 or 300 pounds. An even wider variation occurs in roller bearings. The smallest roller made by S K F

FLASH When it comes out of the dies the ball is roughly spherical, but it has nibs of excess steel at its poles and a raised belt called "flash" around its equator

ROUGH GRINDING After nibs and flash are removed, balls are ground between wheels rotating in opposite directions

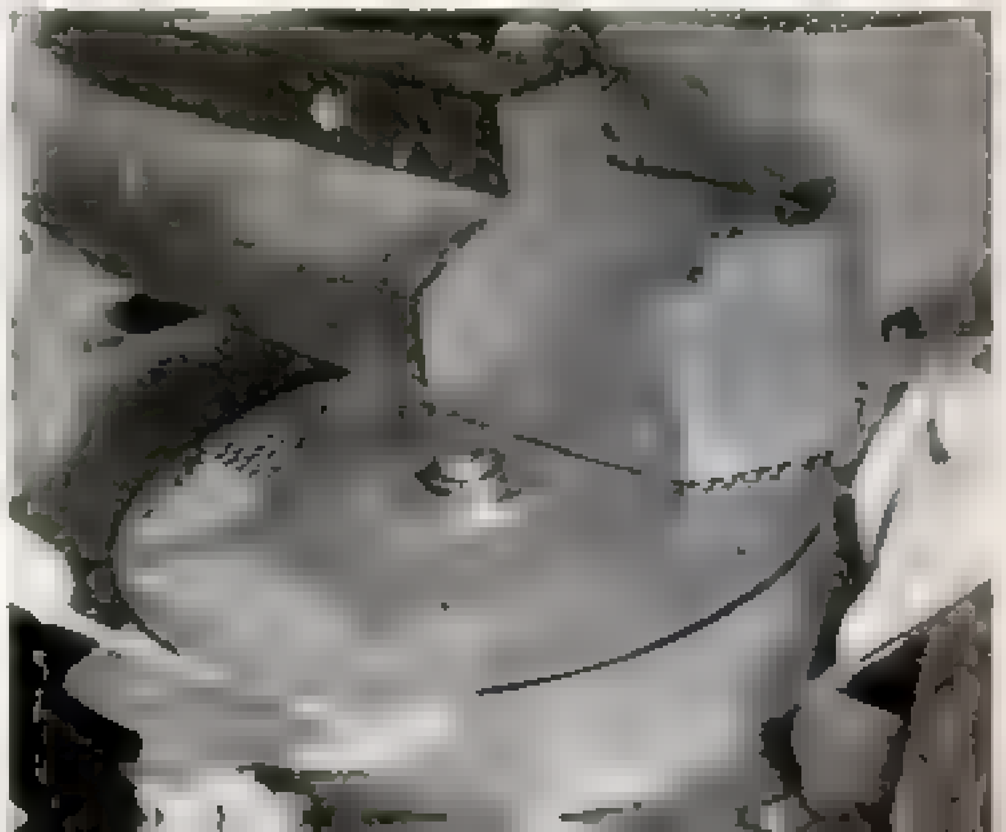


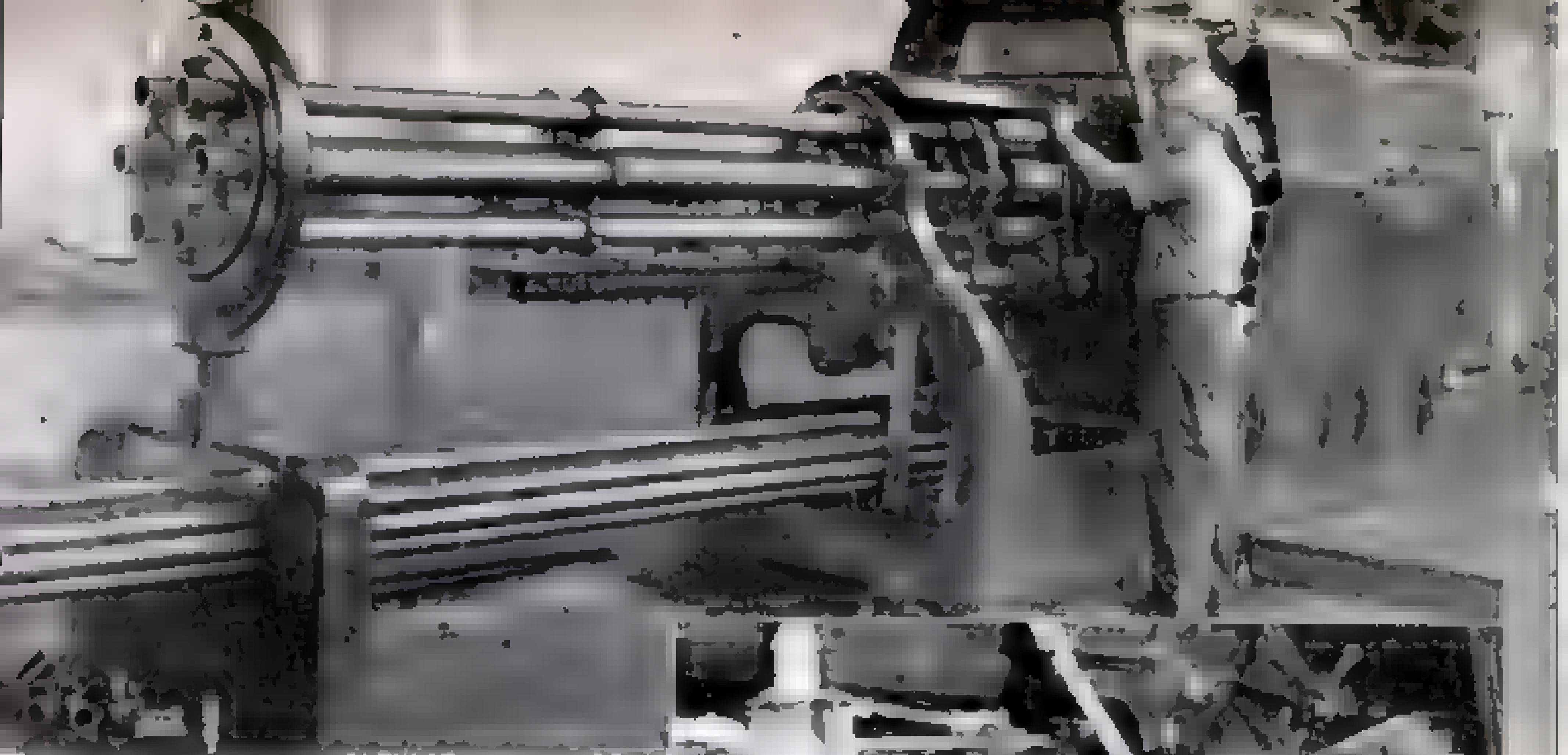
FINE GRINDING About the proper size but with a little excess metal to allow for finishing, the balls now pass through a succession of machines that remove defects and give ever increasing accuracy. As they are always rolling and changing their axis of rotation, all receive the same treatment and are ground evenly.

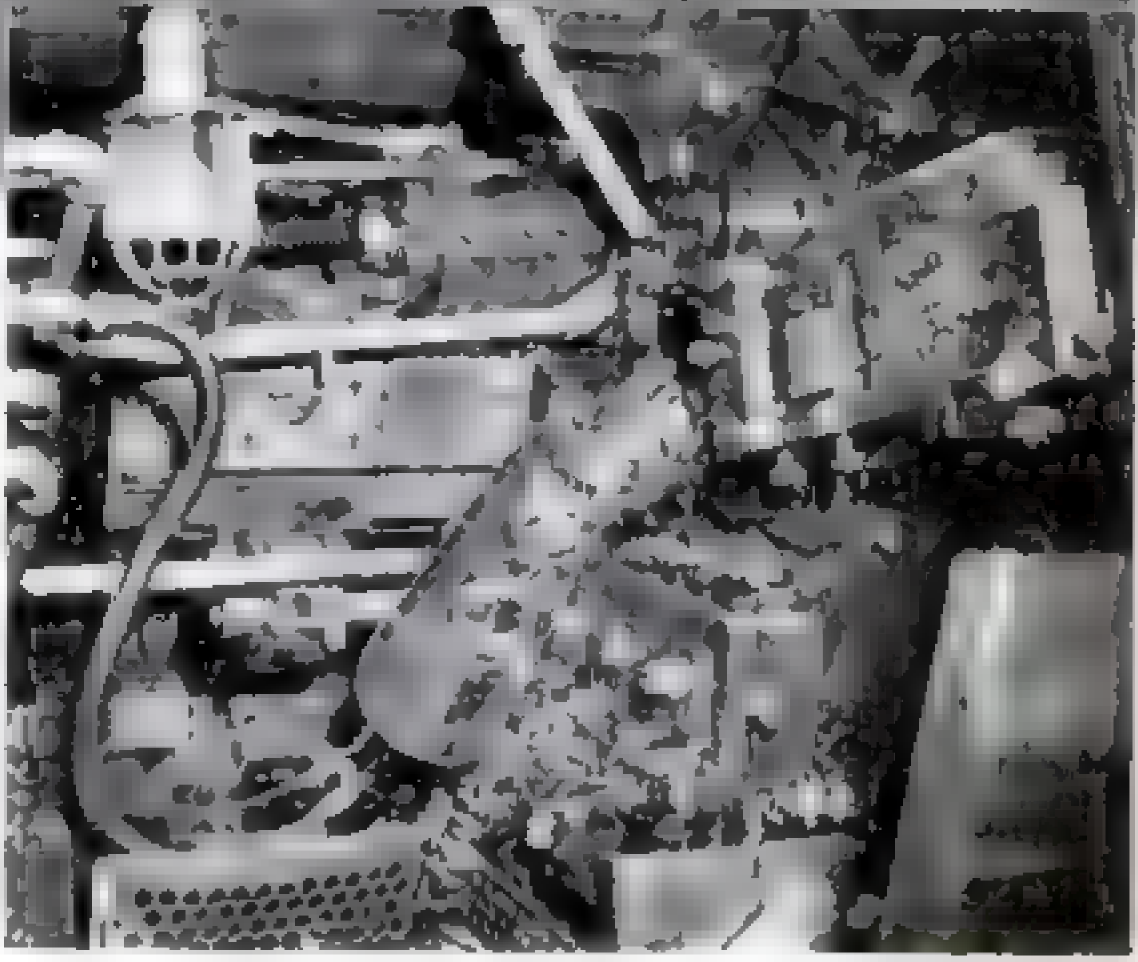
TUMBLING As the final operation in fine grinding, balls are tumbled in barrels as shown above, first with sand and then with bits of glove leather. This ends the soft stage of ball manufacture. From the tumbling barrels the balls go to the furnaces for the hardening and tempering treatments.

GAUGING Rolling down slanting knife-edge blades, balls are sorted for size and drop down a chute into containers.

INSPECTION Finished balls are checked and tested by white-gloved girls in carefully air-conditioned temperature-controlled rooms.







RINGS In six operations, this machine cuts and turns three different surfaces of the inner race ring for a ball bearing. Completed rings tumble out on a chute as seen at right. Each bearing has an inner and an outer race, plus the cage

is five millimeters long and the same in outside diameter, while the largest is about six inches long and weighs approximately 20 pounds. The assembled bearing in which the latter is used will weigh almost 4,000 pounds, and will carry an extraordinarily heavy load.

A ball or roller bearing, whether it weighs a few ounces or hundreds of pounds, consists of four parts the balls or rollers, the number of which depends upon the size and purpose of the bearing; two independent rings, called the inner and outer races, with grooved raceways in which the balls or rollers run; and the cage, which is slotted to hold the balls or rollers in place. Cages are used in all bearings except the full-type, in which as many balls as possible are packed into the raceways. The full-type is not as free-running as the cage-type, but like the roller bearings will sustain heavier loads. The races, as well as the balls and rollers, are made of chrome-alloy steel possessing to a high degree the qualities of hardness, durability, toughness, and resistance to shock. Some of the cages for small bearings are also of steel, but they are usually made of softer and lighter materials. Aluminum is used to some extent, and where extreme lightness is desired the cages are manufactured of textolite plastic. Most, however, are of bronze. Smaller cages are made in two sections, the slotted part and a plate to which it is riveted. The larger cages are made in one piece, a much stronger construction, and the slots are broached by special machines.

The balls or rollers, and the races, which with the cage make up a bearing, are manufactured from steel wire, bar stock, tubing, and forgings. As is obvious, tubing and forgings are used for the races, except when unusually heavy walls are required, in which case bar stock is drilled and reamed according to specifications. Essentially, the manufacturing process consists of a series of pressing, machining, hardening, grinding, and polishing operations carried on in two stages and each followed by rigid inspection and testing. In the first or soft stage, slugs and rings clipped from the rough stock are pressed or machined to approximate size. In the hard stage, which begins when the product comes from the hardening furnaces and the tempering vats, the rollers, balls, and races are ground and lapped to exact dimensions and given the mirrorlike

finish which is necessary if a bearing is to be smooth-running and efficient.

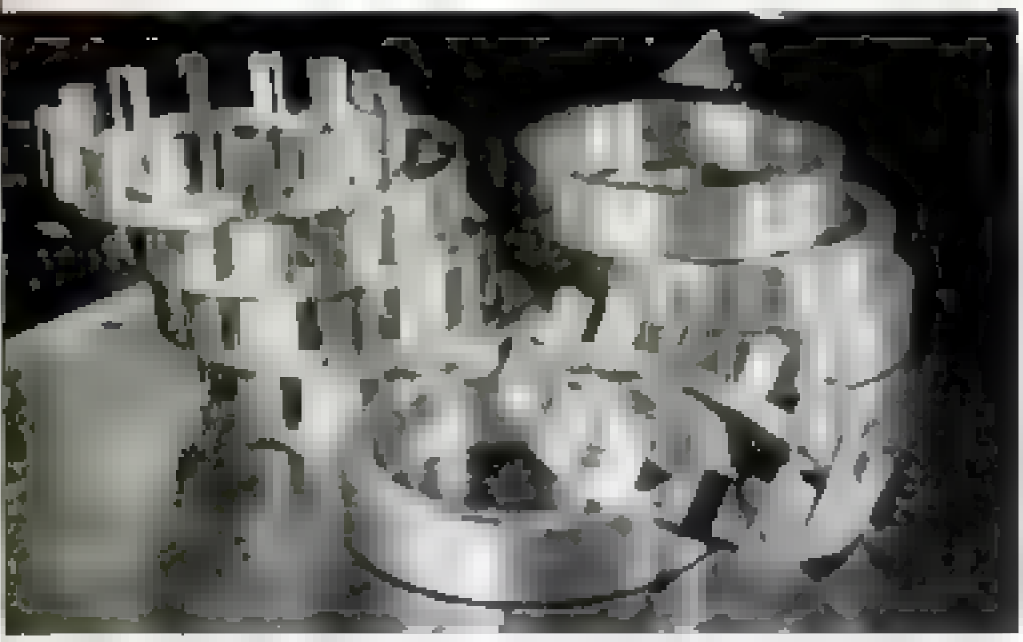
With modern machinery it is possible, even in mass production, to hold the rollers within micrometer limits of plus one and minus one, while balls can be made true to size and spherically within 25 millionths of an inch. In the manufacture of races and rollers, close inspection and tests are made at every step. At the S K F ball and roller plant approximately half the personnel is employed in these services.

In the making of races all operations in the soft stage are performed on a single machine, which cuts, drills, reams, and grooves, and delivers the races complete except for hardening and grinding. Special types of large races are prepared on turret lathes. Similarly, the bar stock for rollers is fed into automatic machines in which slugs are sheared off and machined to the approximate size of the finished roller. Both the rough races and the roller slugs are then given a hardening treatment in gas and electric furnaces heated to 1,500 degrees Fahrenheit, after which they are tempered in oil baths and sand-blasted to remove the oil and surface dirt. The races are then finished on ordinary precision grinding and lapping machines, but the operations on the rollers, especially those of the spherical type, are more intricate, since they must possess extreme accuracy and uniformity. The details of these processes are secret and cannot be photographed or described, but it is possible to give POPULAR SCIENCE readers a fairly comprehensive account of how balls are made.

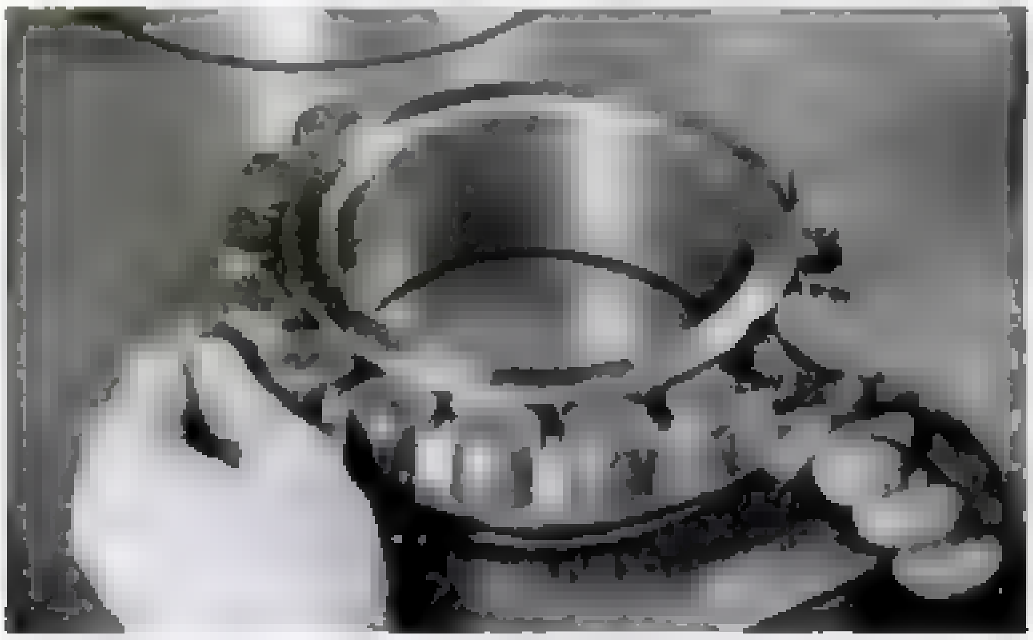
The S K F plant manufactures four grades of balls, all of which are made of the same fine steel and pass through the same operations up to the precision-grinding stage. Grade 1 balls are the finest, and are generally specified for precision bearings, accurate valve applications, and other purposes requiring the greatest possible accuracy and smoothness. In balls of the other three grades wider tolerances are per-

HOW ROLLER BEARINGS ARE ASSEMBLED

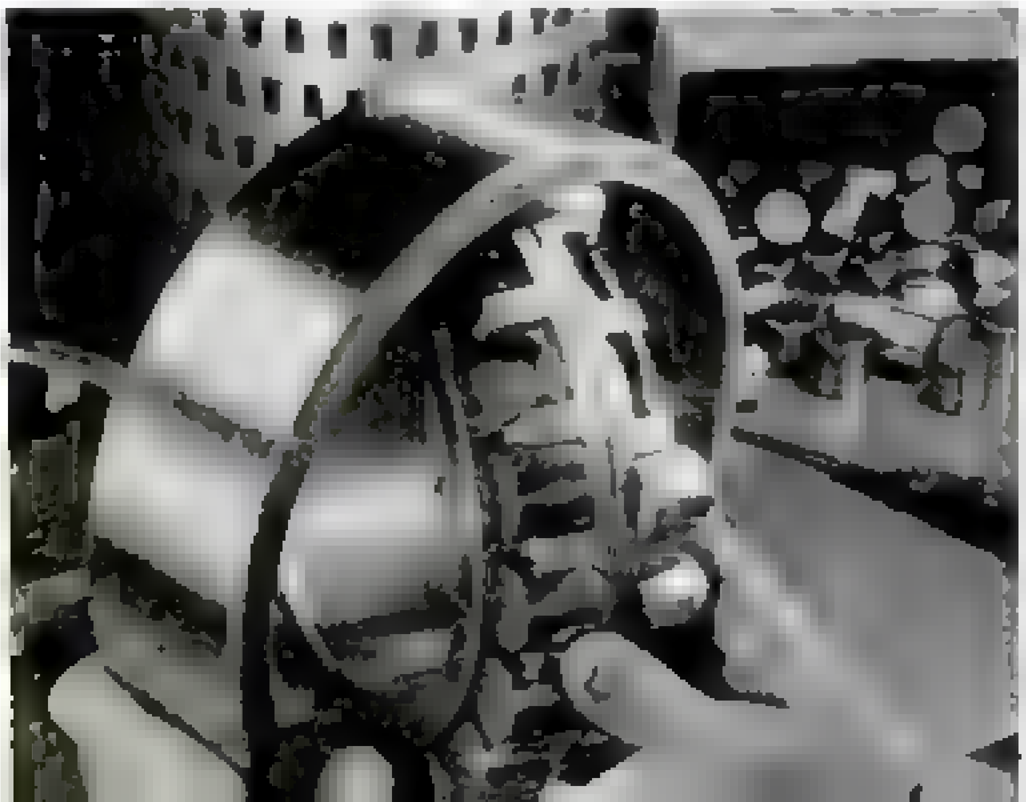
Cages and rings for spherical roller bearings. Like the rollers, the rings are made of tough chrome-alloy steel. The cages, slotted to hold the rollers in their places, may be of bronze or of steel



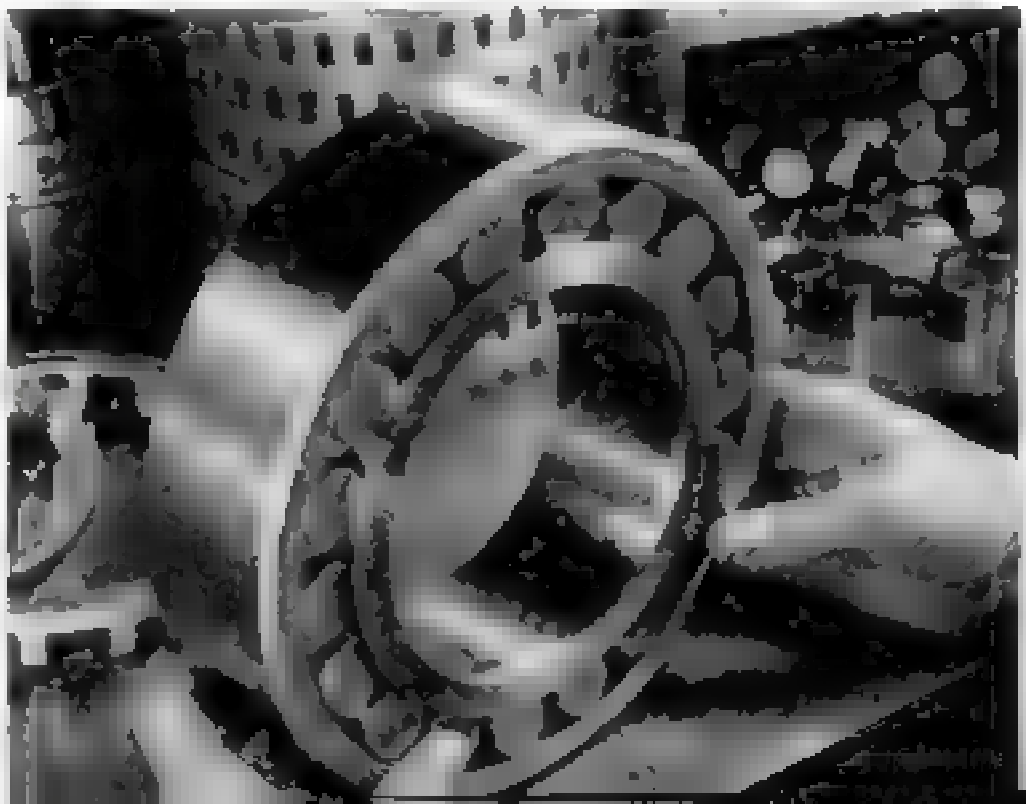
With the cage in place around the inner ring, the rollers are slipped into the slots as seen in the photograph below. Manufacture of rollers requires frequent inspection and checking of size and shape



In the photograph below, cages and rollers of a spherical roller bearing are being put in the outer ring. A few rollers still remain to be inserted



This is the assembled bearing. Roller bearings do not run as freely as ball bearings, but can carry heavier loads because of greater strength



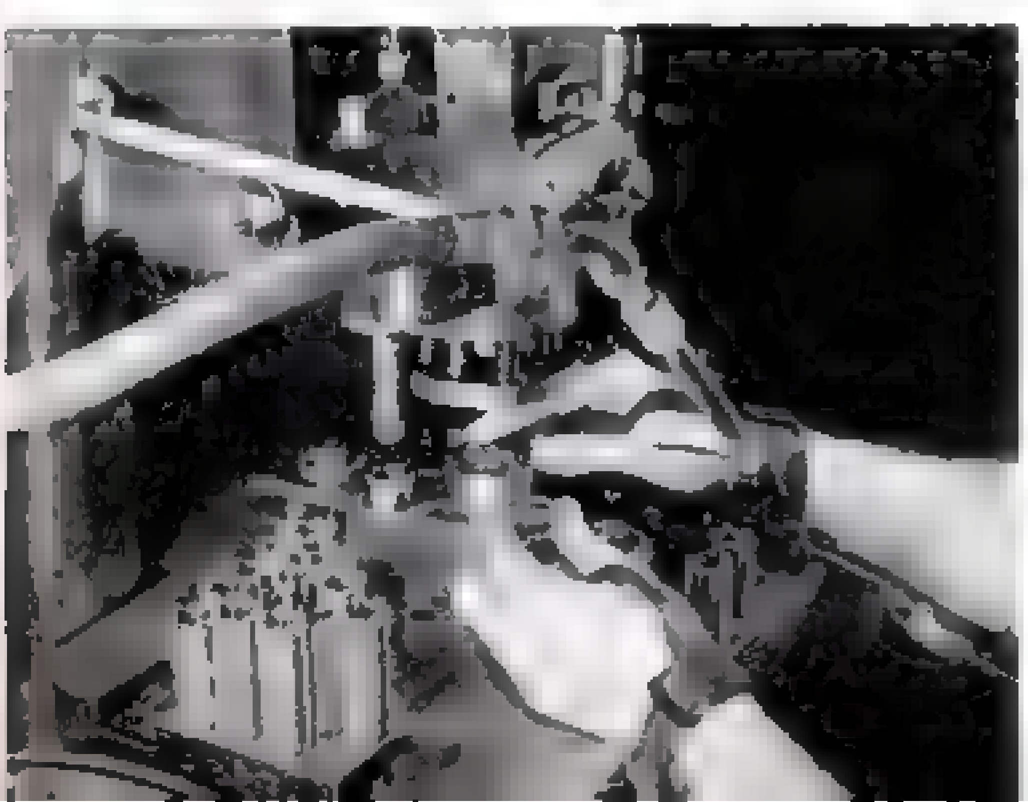
BALL BEARINGS Assembly of a large ball bearing is illustrated above. At the left balls are being set in a cage with the aid of a mallet. At the right, the cage is being combined with the races. Though bearings differ in size and type, the principle is the same

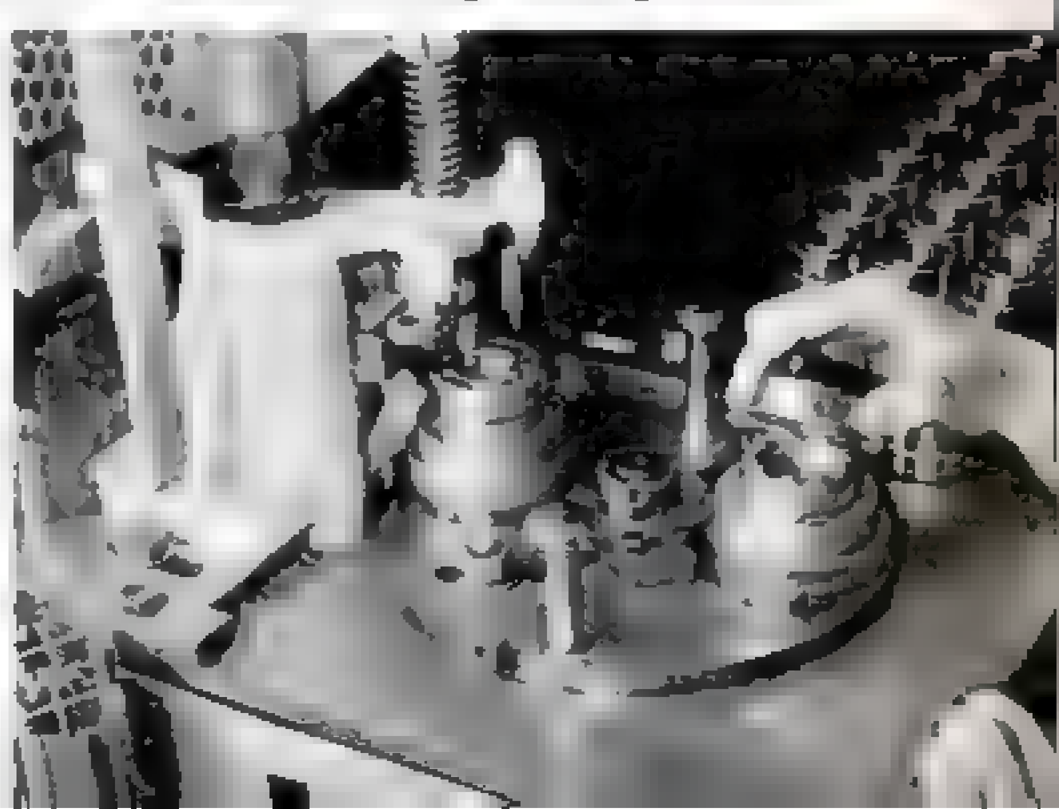
missible. The time required to manufacture a ball varies according to grade and size. Grade 1 balls three-fourths of an inch in outside diameter, usually put through in batches of about 4,000, usually take 11½ eight-hour days. Balls an eighth of an inch in diameter, manufactured in batches of several hundred thousand, take 36 eight-hour days. A batch of 1,750 one-inch balls requires 10½ eight-hour days. These are all prewar figures. Since Pearl Harbor they have been considerably reduced.

The first step in making a bearing ball is to shear off a small piece of steel wire, if the ball is to be less than one inch in diameter, or of bar stock if it is to be larger than one inch. For the smaller balls the pieces are cold-pressed, at the rate of 400 a minute, between two cup-shaped dies; but for the larger balls the pieces are heated before being fed into the dies. No machine has yet been invented which will satisfactorily cold-press a ball larger than one inch in diameter. When the ball comes from the pressing dies it is roughly spherical and considerably larger than the contemplated size of the finished ball. Most of the excess steel is in two small nibs at the poles of the ball, and in a slightly raised belt around the equator, called "flash." Both the nibs and the flash are removed in the second operation by a machine called a "flasher," the grinding part of which consists of two file-cut disks of hard steel, the upper stationary and the lower rotating. About 500 pounds of balls are poured into a large hopper, from which they are fed into the area between the disks.

When the flasher gets through with the balls they are pretty close to proper size, but from the point of view of a ball manufacturer they are still much too large. Three-fourths-inch balls, for example, are .035 inches oversize. Experience has shown that this is the correct amount of excess steel to allow for the removal of surface defects, and to give the grinding operations enough leeway to obtain the required ac-

CAGES for deep-groove bearings are made in the form of two wavy metal rings that are riveted together to hold the balls in place. At left, below, holes are being punched in the rings to receive the rivets. At the right, rivets are being inserted. Note the rows of bearings awaiting treatment





curacy. These operations begin on a rough grinder in which the balls roll in a slot between an upper driving ring which moves counterclockwise at 60 r.p.m., and a lower grinding wheel rotating clockwise at 900 r.p.m. This machine will rough-grind a little more than 1,000 balls an hour.

This variation is reduced to .0001 inch by the multiple-groove grinder, in which the balls, traveling in steel-walled grooves, are passed and repassed over a series of grinding plates. The balls then go to the tumbling barrels, where they are rolled in abrasive grit, oil, and water, in huge drums, each holding about 1,000 pounds of balls and rotating at 30 r.p.m. Some types of balls are finished in these drums, and are given a mirrorlike finish by being tumbled with strips of soft glove leather. The smaller rollers also are tumbled, but the larger ones are not, as the contact would mar their edges.

Tumbling is the final operation in the soft stage of ball manufacture. From the tumbling barrels the balls go to the furnaces for hardening and tempering, the procedure being the same as for races and rollers. Balls picked at random from each batch are tested for hardness and toughness on a 400-ton hydraulic press, and if a certain percentage fail to stand up under the terrific strain, indicating steel of coarse grain structure, the entire batch is rejected. Those that pass the tests are precision ground, rolling for hour after hour against a grinding wheel 24 inches in diameter and rotating at 60 r.p.m. The balls in going through this machine follow a path determined by guide plates, and after 12 hours of constant grinding are true to size and sphericity within one-half of one ten-thousandth inch.

The manufacture of three of the four grades of balls made by S K F ends with precision grinding, but the Grade 1 balls are carried one step further—they are lapped on machines resembling flashers. Immersed in a special lapping compound, the balls are rolled between two grooved metal plates, the upper of which is stationary while the lower rotates counterclockwise in a spiderlike fashion. This operation splits the previous tolerance of one half of one ten-thousandth in two, and brings the balls within 25 millionths of an inch of being the exact size specified. It also imparts a finish compared to which a rose petal is so much sandpaper. To further insure that all assembled bearings will contain balls of almost absolute uniformity, all balls are put through sorting machines, each containing two slanting knife edges adjusted to within millionths of an inch. Balls rolling down these knife edges drop into different pockets according to their size and go into the proper bins.

From the sorting machines the balls go to the inspection rooms, all of which are air-conditioned, with a constant temperature of about 70 degrees Fahrenheit. There they are checked and tested for appearance, surface defects, roundness, size, and diameter on gauges which are frequently checked by precision gauge blocks.

BIGGEST BEARING made by S K F uses rollers about ½ foot long, weighing approximately 20 pounds. Here the outer surface of its ring is being measured with a giant-size micrometer

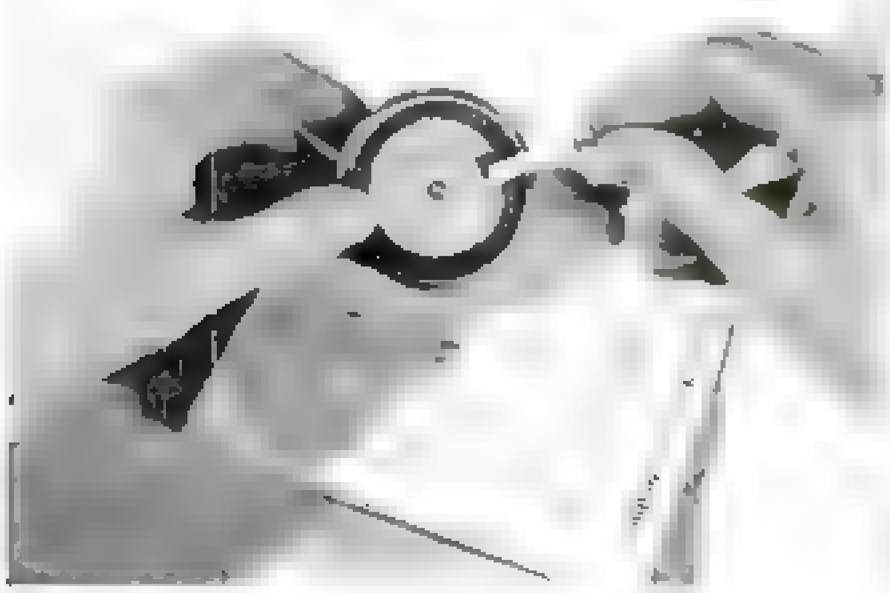
SOIL TESTER

Simp e Outfits Can Be Used by Home Gardeners

Collecting soil for a test. Knowing whether it is acid or alkaline, the gardener can choose plants that will thrive, or treat soil with chemicals

SIMPLE soil-testing devices now available to the home gardener make it easy to determine whether soil is acid or alkaline. One kit, consisting of a single solution and a color chart for comparison, shows twelve degrees of acidity or alkalinity in terms of pH, or hydrogen-ion concentration. Water that has been mixed with the soil to be tested is filtered and put in a test tube. When a little of the indicator solution is added, it takes on a color which can be compared with the chart. An even simpler device is a roll of paper ribbon impregnated with an organic indicating substance. A piece of this is moistened with water off a soil sample in a spoon, and the resulting color is compared with a color scale on the ribbon reel. Knowing the soil's condition, the gardener may plant adaptable plants or chemically treat the soil.

This color chart, included with one kit, shows 12 degrees of acidity or alkalinity when compared with the color produced in an indicator by a soil sample



In another device, a strip of test paper impregnated with an indicator is moistened with water off the soil sample and matched with a color scale on reel

How thermometer bulbs are formed, left. Held in flame's point, the tube end is blown to shape by rubber bulb. The size is fixed by testing in the graduated holes of gauge at woman's shoulder, as in close-up

Making Fever Thermometers Is a Scientific Business

FROM BLOWING THE GLASS TO CALIBRATING, IT CALLS FOR SOME 105 OPERATIONS

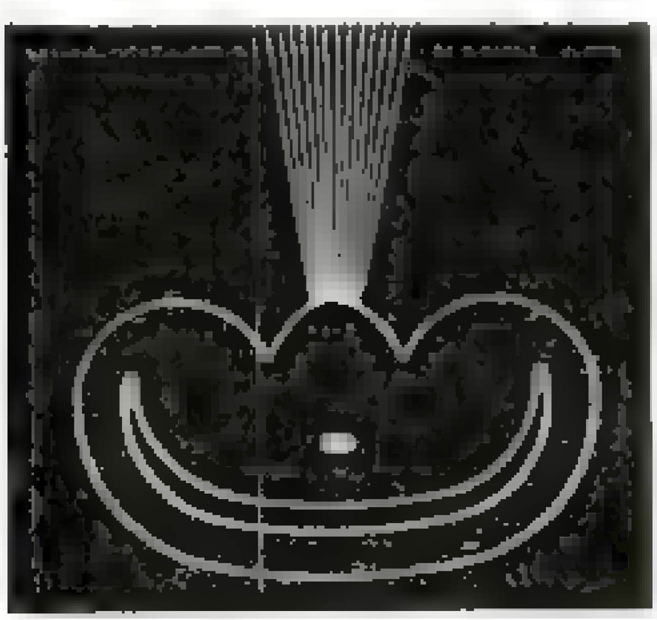
BASICALLY the clinical or fever thermometer is simply a piece of glass and a drop or two of mercury. But approximately 105 manufacturing and inspection operations, requiring from six to eight months for completion, are necessary to combine them into the fragile and delicate instrument which is the physician's almost constant companion. This long series of processes, some of which take only a few seconds, begins in the glass manufactory when workmen lift from the furnaces a "melt" of silicates of potash, soda, lime, magnesia, alumina, and lead. This melt becomes the glass tubing which in turn, with the addition of the mercury, becomes the fine thermometer guaranteed to provide temperature readings accurate within one tenth to three tenths of a degree.

The value of a thermometer depends to a large extent upon the grade of glass used, and especially upon the skill and care with which the glass is turned into tubing. The

first step in tube making is to dip a hollow iron rod, about five feet long and an inch or so in inside diameter, into the melt, and to collect on the end of it a mass of molten glass the size of a milk bottle. This mass is allowed to cool to a plastic state, and then a bubble, later of the utmost importance, is blown into its center through the iron rod. It is then rolled over an iron plate until it becomes cylindrical, an operation which imparts a cylindrical shape to the bubble. The top and bottom are flattened by pressure, which also flattens the bubble a trifle.

A strip of white enamel glass is now fused to one side of the mass, to provide a reflecting surface and make for easier reading of the completed thermometer. It is then dipped into the melt and completely covered with a thin coating of new clear glass. A waviness which has developed is removed by rolling the mass on an iron

TUBES, shown in cross section, have lenses and reflectors to make fine columns visible. The one below has a triple lens and a wide reflector



In a fine thermometer, the bore (B) is from one tenth to one twelfth the size of a human hair (A)

slab, a process which also gives it solidity. The mass is then put into a V-shaped mold, with the enameled glass uppermost. This shapes it into a rough triangle, and by distortion forms the lens through which the mercury can be read. The glass when it comes from the mold is a section of heavy, wedge-shaped tubing, with a hole in the center, the whole being about nine inches long and some five inches in diameter. The white glass is directly behind the hole and the lens directly in front of it. The entire mass is still stuck on the end of the iron rod.

The glass is now ready for the most delicate operation of the entire manufacturing process—it must be pulled out or drawn into thin tubing. Workmen begin this operation by placing the mass, which is still plastic, on the surface of a hot iron plate about eight inches in diameter, with the hollow rod pointed upward. The rod is fastened to a wire cable, on a small motor. When everything is ready, the motor is started and the glass slowly pulled upward. At the conclusion of this operation, the glass has been drawn into a thin tube from 90 to 150 feet long, and in every respect save length the exact size of the thermometer in your medicine chest, with a lens in front and the familiar surface of white enamel in the back. The bubble, once an inch or more in diameter, has been so elongated that it varies in size from one tenth to one twelfth the thickness of a human hair. This is the bore of the thermometer, the tiny hole along which the mercury travels to give its messages of warning or reassurance.

With the exception of short sections at either end, which are useless because of strains and distortions, the long tube is now ready to be cut into six-foot "canes" for delivery to the thermometer manufacturers. In some factories the canes, if destined for clinicals, are cut into eight-inch lengths,

twice the size of a completed thermometer. Each of these small tubes, after inspection and grading, is held with its center in the blue flame of a blow pipe. When the glass becomes plastic it is pulled apart to make two complete tubes, each sealed at one end. But at the plant of the Taylor Instrument Companies at Rochester, N. Y., the world's largest manufacturers of themometers, the canes from which clinicals are made are cut into four-inch lengths and both ends are left open. Each length is then put through a long series of measuring inspections before the actual work of making the thermometers begins.

The diameter of the bore governs exactly the size of the bulb which is to contain the mercury. If both bulb and bore are large, or both small, the mercury will rise much more slowly than if the bore is small and the bulb large. It will always rise more slowly in a large bore than in a small bore. Because of these factors, and the minute variations in the bore of the canes, the work of grading and measuring requires great skill; measuring the diameter of the bore must be done by means of hair lines under a powerful microscope.

Once the diameter of the bore has been determined within infinitesimal limits, the tube is ready for the bulb to be placed on one end. There are two principal methods of accomplishing this. In one, generally used on some weather thermometers and on cheaper grades of clinicals, the operator begins by attaching a rubber bulb to the open end of a four-inch length of tubing. He heats the closed end, and presses and manipulates the glass at that point until it has become plastic. He then squeezes the rubber bulb, forcing air down the tube to form a bubble when it reaches the plastic glass. He knows from experience just how much pressure to apply, and checks the operation as he works by means of iron plates in which holes of different sizes have been drilled. In the other method, used at the Taylor plant for fine clinicals, the bulb is blown separately out of a hard glass of special composition, and is fused to the tube while both are in a plastic state. This method is slower, but is also more satisfactory, for the bulb can be measured beforehand and matched with the correct tube.

While the bulb and tube are still hot from the fusing operation, they are immersed in a jar of mercury, which has been distilled and redistilled, since the least speck of dirt would upset calculations and prevent proper calibration. As the glass cools, the air in the thermometer contracts and the mercury is drawn into the open end of the tube and passes down the bore into the bulb. This operation is repeated until the bulb contains the required amount. Then the end of the tube is heated and drawn out to a hollow point. Heat is now applied to the bulb, and as the mercury travels up the tube completely filling the bore, the air is expelled. At the proper moment the end is snipped off and the tube sealed.

The tube now begins to resemble a thermometer; it has been closed at both ends, it is the proper length, and the bulb is full of mercury. After a thorough inspection, it goes to an operator who rotates it slowly by hand in a tiny point of blue flame. He does this with the utmost care, for the slightest variation in the intensity of the flame or the subtlest shift in angle or tension, would cause flaws and eliminate the tube from the production line. At a certain stage, when the glass has become plastic and malleable, the operator suddenly exerts pressure just above the fusion point of the bulb, collapsing the bore at that one point until it is approximately one forty-thousandth of an inch in diameter. The bore is now too small for the mercury to travel slowly and gradually up the tube, but as the bulb becomes warm the substance is ejected into the bore by a series of jerks; the pressure spits the mercury past the contraction point and so up the tube. It will remain at the maximum temperature registered indefinitely, and can never return to the bulb except by centrifugal force, which is applied by vigorously shaking the thermometer. The force necessary has been carefully calculated, and each instrument is tested on a special machine. A thermometer without this contraction feature is known as a "retreater."

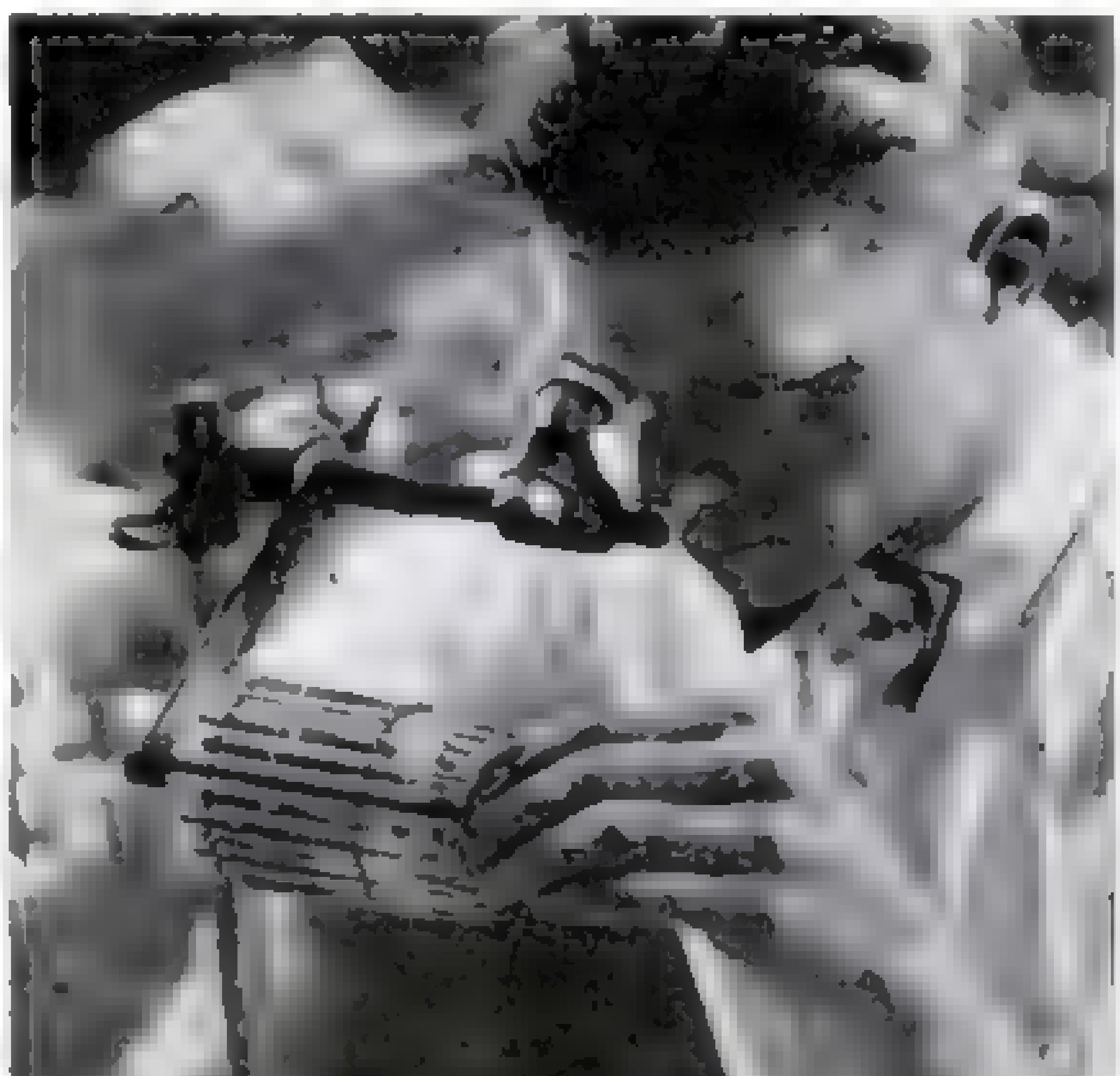
When the mercury has been blown into the bore, the tube is a complete thermometer except for marking and calibrating. But the glass of which it has been made is "green," and must be aged to work out the stresses which were introduced by pulling and handling. This requires from five to seven months and cannot be hurried. At the end of that time it is withdrawn from storage and subjected to elaborate tests. If it has reached a state of equilibrium, it is sent to the calibrating bath to have the points established. Taylor thermometers are pointed at 96 and 106 degrees Fahrenheit, and are tested twice with microscopes at 96, 102, and 106 degrees. Standards are frequently checked against a resistance thermometer capable of measuring to within one one-thousandth of a degree.

The calibrating bath, elecrically controlled, is held at a temperature of 96 degrees within one one-hundredth of a degree. When a

Checking a thermometer tube's bore with a powerful microscope

thermometer is taken from the bath, the mercury will be at 96 degrees, and will remain there because of the contraction in the bore. The highest point reached by the mercury while in the bath is determined by microscopic examination, and a scribe mark is made on the tube with a fine file. The thermometer is then put into another bath which is controlled at 106 degrees, and the same procedure followed, after which the instrument is dipped into molten wax and put into an engraving machine with a stylus set to strike exactly on the scribe marks. If this setting is properly made the machine will also automatically average variations and gradations from the lowest to the highest readings. The thermometer is then dipped into hydrofluoric acid, which eats into the glass wherever it has been exposed but has no appetite for the wax. Serial numbers and trademarks are put on in the same manner.

Below, final microscopic study before certifying the instrument



After the acid has done its job, the wax is melted off and the markings are painted with pigment. This part of the manufacturing process has long been a headache to thermometer makers because so many people insist upon using harsh sterilizing liquids which obliterate the colors. The Taylor Companies recommend sterilization in alcohol or a five-percent phenol solution. Never use boiling water—a clinical is made to register not more than 108 degrees, and something is bound to pop.

Each completed thermometer, marked and calibrated, is sent to the calibrating baths for a second and final test, and is then carefully read with a microscope, variations noted, and a certificate made out. The Taylor Companies set out to make a single grade, but natural variations divide the product into two, equally accurate.

MOTORCYCLES FOR

FOR many years a military orphan, used to some extent by all branches of the Army but of real importance to none, the motorcycle has at last found a definite place in the ranks of America's new fighting forces. It has been adopted by the Armored Force, and extensive plans are being worked out to exploit its tactical values and to utilize its speed, maneuverability, and rapidity of action. Described in an Army manual less than two years ago as "perhaps the least understood and most abused vehicle used in the military service," the motorcycle now seems destined to become a combat vehicle second in importance only to the amazingly efficient little quarter-ton truck, which incidentally has taken over many of its traditional functions. In fact, the quarter-ton has made the sidecar and the tricycle obso-

One of the new shaft-driven motorcycles goes over the top at a quartermaster base where these experimental machines are being tested. Models are shown in detail on following pages

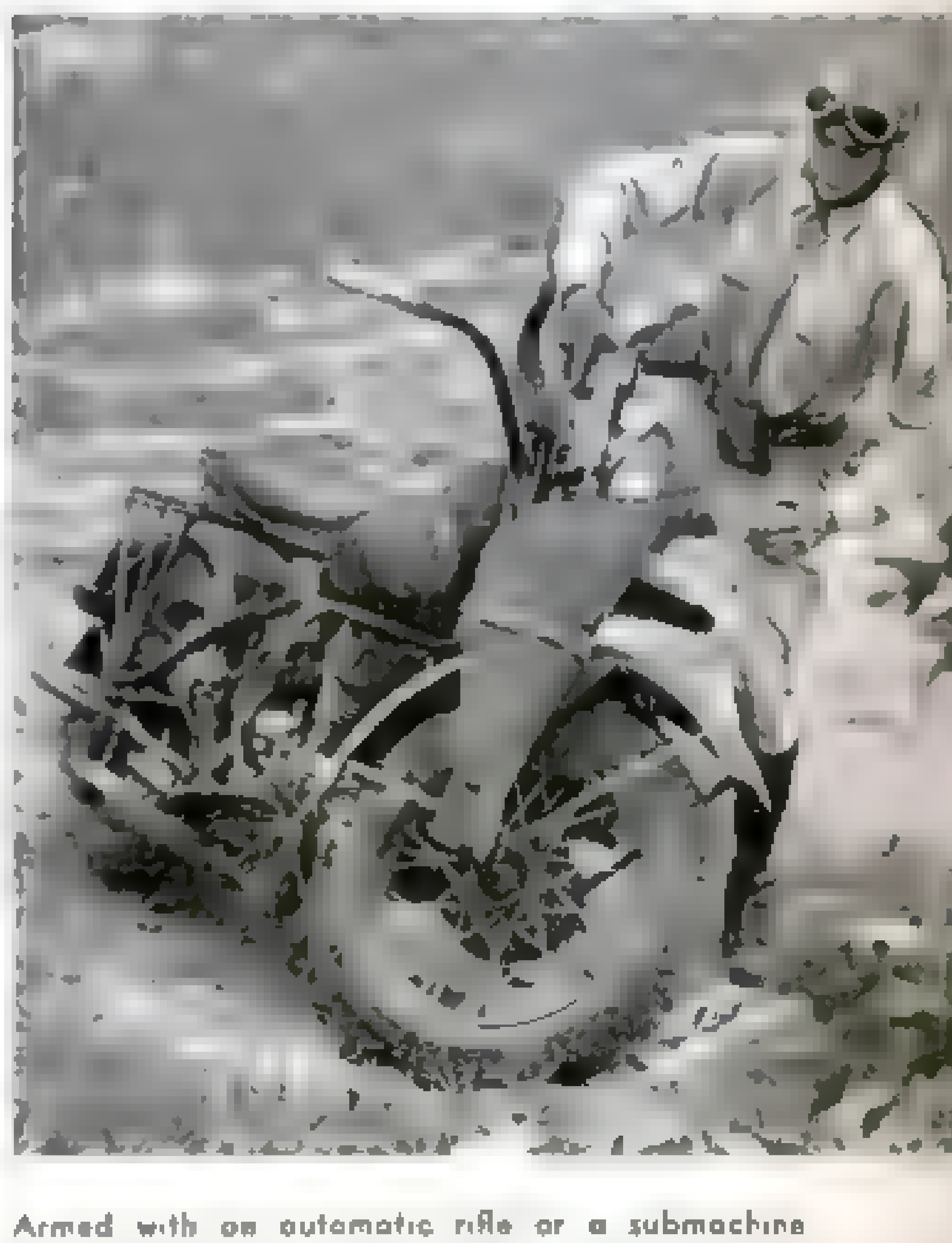
Motorcycle troops are now being taught assault tactics. Here an artist's conception shows a motorcycle column that has been rushed to attack an enemy's flank

Maintenance is important, for the motorcycle is subjected to extremely hard wear in the field. To keep the machines in repair and ready for use on short notice, soldier mechanics learn their part in mechanized war at the Army motor schools

COMBAT

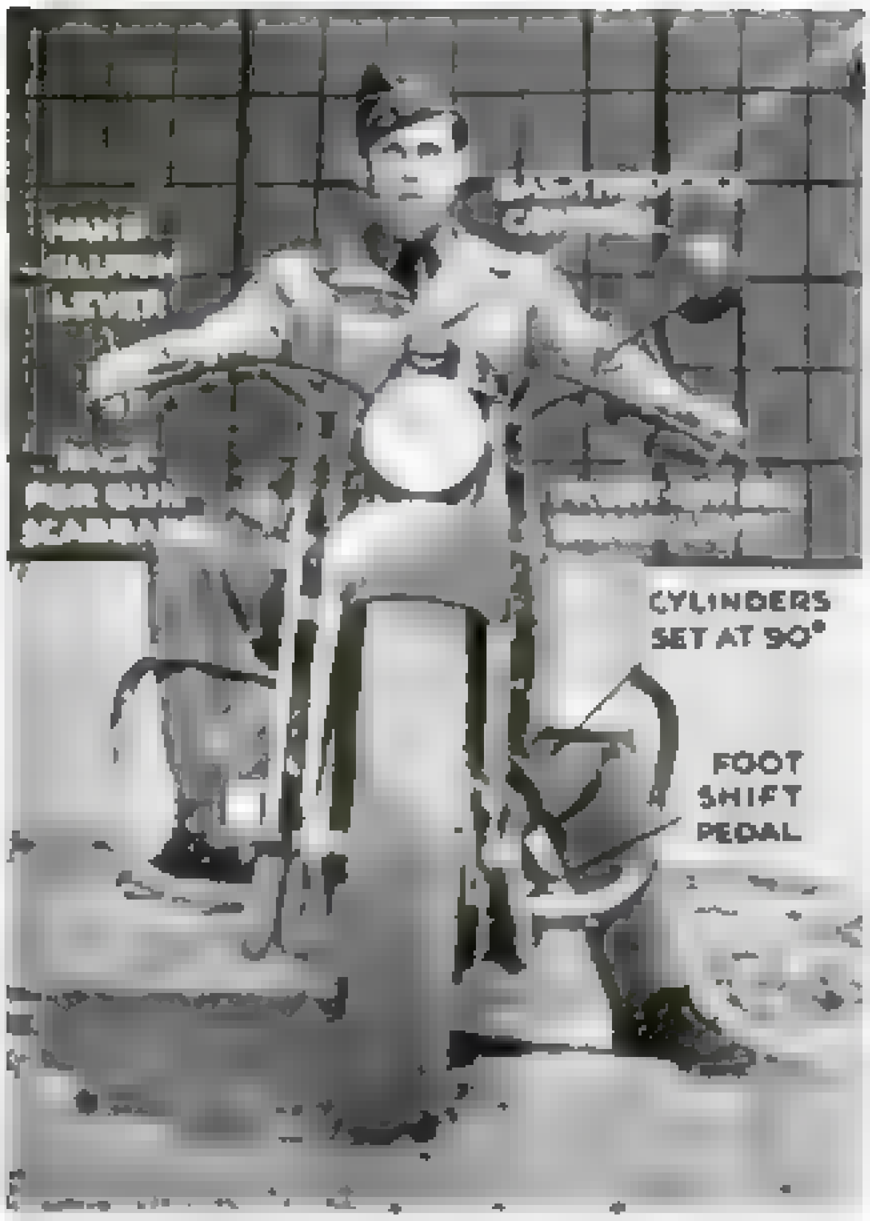
lete, except for certain infantry applications.

The principal use of the motorcycle probably will be as a scouting and reconnaissance vehicle with mechanized troops, for which it is peculiarly fitted. But the Armored Force is also developing its possibilities as an actual combat machine. Motorcycle troops have been organized into squadrons, and at Fort Knox and other posts in the South and Southwest are being intensively trained, not only in scouting and reconnaissance activities, but also in the tactics of assault. In Texas both scouting and assault units are being taught what the Army calls "new stuff," which is particularly applicable to operations in desert and other open country. Details of this "new stuff," of course, are a military secret, but much of it is based on the fact that the motorcycle has a low silhouette and consequently offers a comparatively small target. The machines used by the new motorcycle troops are not armored, but are fitted with rifle scabbards



Armed with an automatic rifle or a submachine gun, today's motorcycle soldier becomes a fast hard-hitting trooper who is valuable for surprise thrusts at enemy columns moving across country

ARMY TESTS EXPERIMENTAL SHAFT-DRIVEN MOTORCYCLES



Indian

This experimental shaft-driven motorcycle is now undergoing exhaustive Army tests in the hope that it may prove the end of the quest for a machine that will stand up under terrific punishment. To provide needed extra cooling, the two cylinders of its V-type motor are fanned out into the air stream at an angle of 90 degrees to each other

TAIL LIGHTS AND EXHAUSTS. Two tail and stop lights are used, one for ordinary riding and one for blackouts, and are mounted one above the other. The twin exhausts have circular openings

SHAFT DRIVE. Replacing the chain, it keeps out dust and sand. This cycle is an Indian, but Harley-Davidson construction here is very similar

FOOT GEARSHIFT PEDAL. Pushing down with the toe shifts to a lower gear; with the heel, to a higher one. Clutch control is on the handlebar

and saddlebag equipment. The men who ride them into battle will be heavily armed, carrying pistols and possibly grenades as well as rifles. They will also wear special uniforms, with stout leather boots and crash helmets similar to those worn by tank crews.

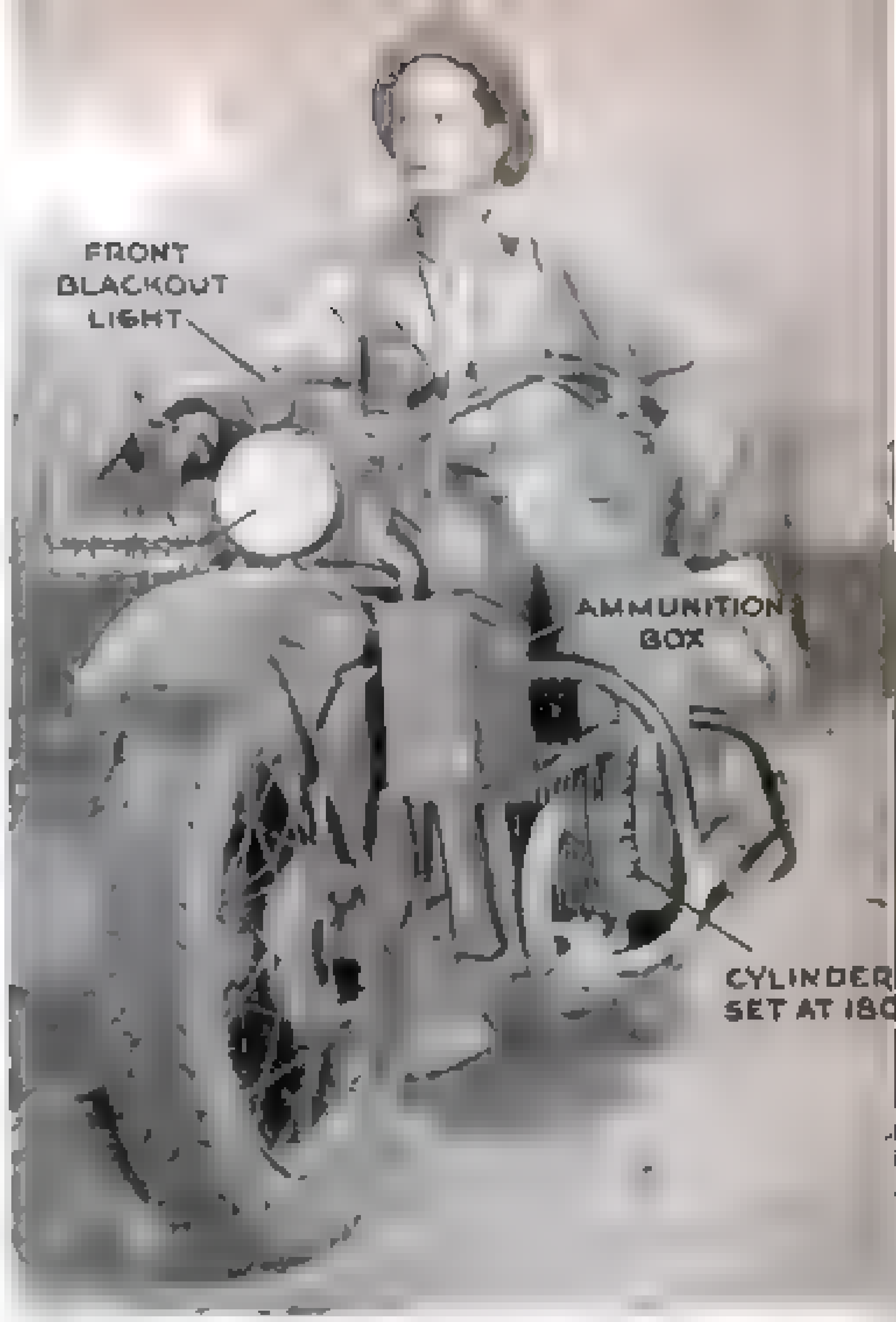
Training begins with a course on operation and maintenance. This is followed by almost constant riding practice, during which the soldier learns how to climb hills, make sharp turns, use the body for balancing, stop and start on a steep slope, fall without injury, and use the motorcycle as a shield against enemy fire, as the old-time cavalryman used his horse. Tactical exercises begin as soon as the troops have become more or less expert riders.

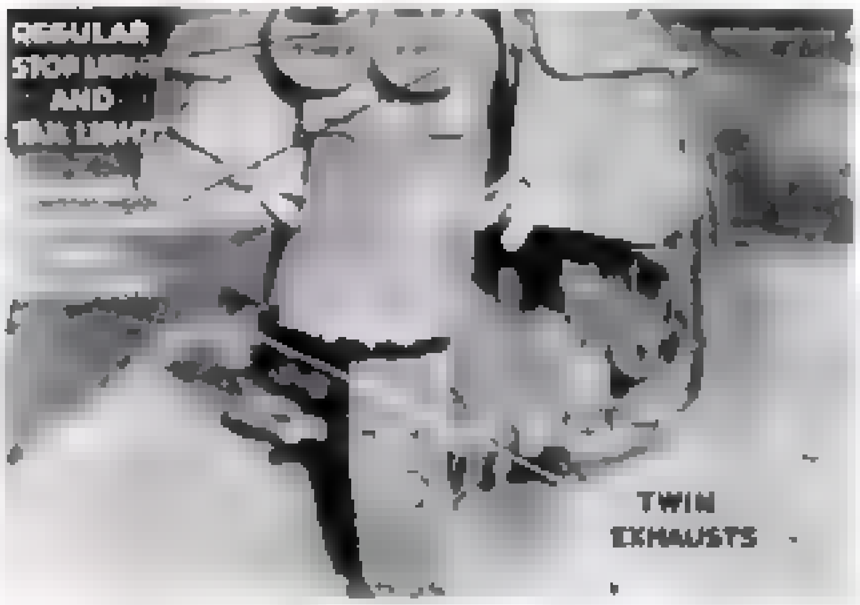
In the early maneuvers which followed the reorganization of the Army, the motorcycle accompanied and supported the tank. Today, organized and trained as a separate force, motorcycle troops are assigned to special tasks. Squadrons will be incorpo-

FOR USE IN MODERN WARFARE

Harley-Davidson

Also getting hard knocks in the Army's tests is the experimental machine at right. Its cylinders are set out into the air stream at an angle of 180 degrees to each other for additional cooling. Soldiers who have ridden both these new models say they are easier to operate and maneuver than the conventional type. The experts are still watching





TAIL LIGHTS AND EXHAUSTS. Here the regular and blackout tail and stop lights are mounted on the mudguard side by side. The twin exhausts, also differing from the Indian, have slit openings

FOOT GEARSHIFT PEDAL. On this model the pedal is pushed down with the toe to shift to a lower gear, but the pedal is not a rocker . . .

. . . and it is pulled up with the toe to shift to a higher gear. As with the Indian, the clutch is controlled with a lever set on the handlebar

rated into the mechanized cavalry regiments. The infantry regiment will have but a few of the machines, one for regimental headquarters and one for each battalion. The old-time dispatch rider will not be seen in this war, except perhaps in extreme emergencies, for his job can be performed more efficiently by the two-way radio.

The machines now being used by the motorcycle troops are the conventional chain-driven Indians and Harley-Davidsons which have been standard Army equipment for several years. Eventually they may be replaced by two new types of shaft-driven motorcycles, embodying many new features and designed to operate efficiently over rough country and to minimize the factors which ordinarily contribute to breakdowns and accidents. Both of these types, one made by Indian and the other by Harley-Davidson, are being put through severe trials at the Holabird Quartermaster Motor Base in Baltimore.

In designing a (Continued on page 212)

Save that Sponge

By ALFRED H. SINKS

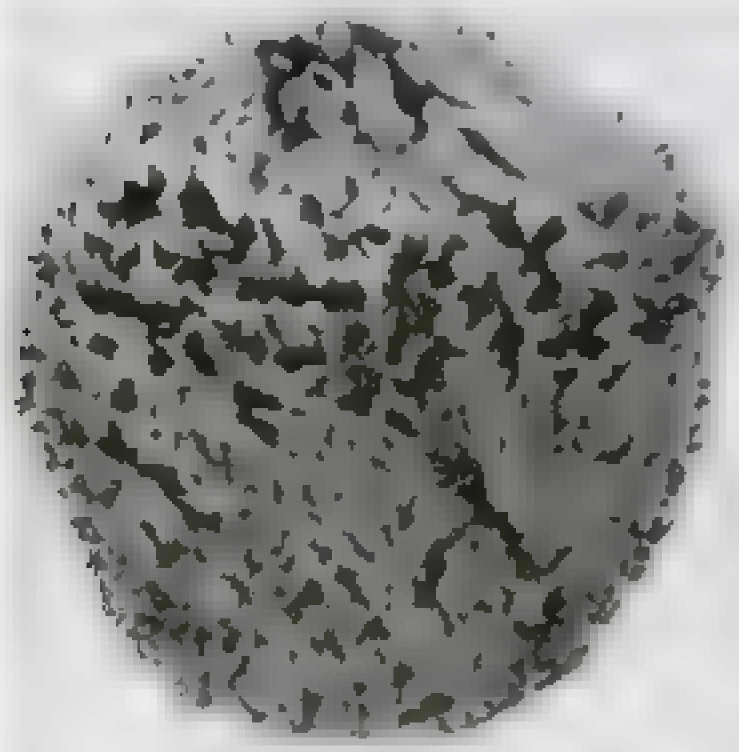
IF SOMEBODY doesn't do something about it in a hurry, there aren't going to be any sponges. No sponges to swab out the big Navy guns that blast away at Jap ships in the Pacific, or the big railway guns that defend our coasts. No small sponges for surgical dressings in military and civilian hospitals, no sponge cuttings for insulating material or for the score of important industries that have never found anything to take the place of that fascinating natural freak—the sea-born sponge.

Since the sponges that live in the waters off the southeastern corner of the United States took sick three years ago prices have quadrupled, available supplies fallen off by two thirds, and the men who go down under the sea for sponges face greater and greater hazards. What exactly was the "blight" that in the space of a few weeks spread over the "mud banks" of the Bahamas, swept around Cuba's northern coast, up through the Florida Keys, and into the Gulf of Mexico?

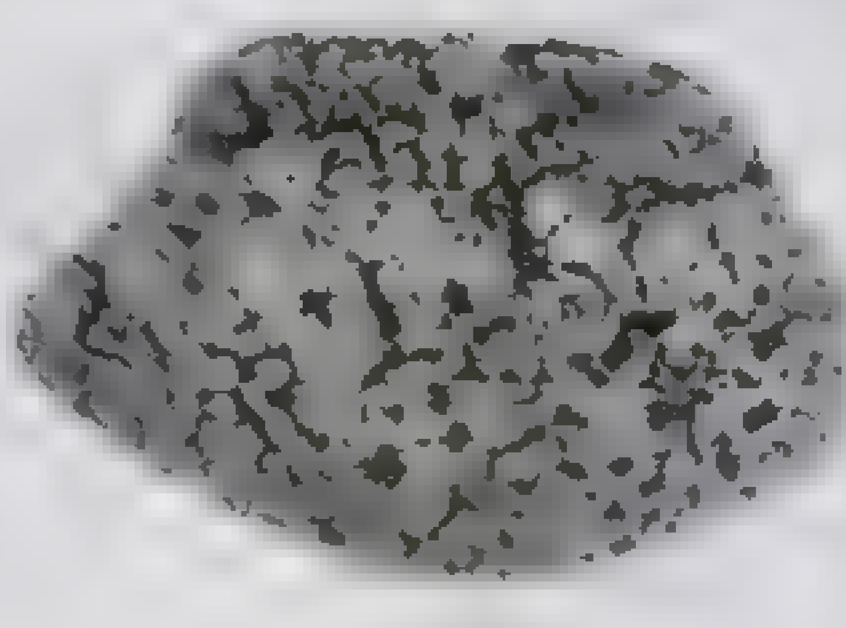
Dr. Paul S. Galtsoff of the U. S. Bureau of Fisheries found a fungoid micro-organism seemed to be the cause. Dr. Roy W. Miner, curator of the American Museum of Natural History, found that not sponges alone but all life on the ocean floor had suffered. Granting that a fungus may have been the immediate cause, Dr. Miner puts the blame on the unusually low water temperatures early in 1939. But nobody really knows. Dr. F. G. Walton Smith is planning an undersea expedition in another attempt to solve the riddle. Meantime sponge dealers declare that there are plenty of sponges off the Florida coast that can't be touched until the state repeals a law that prohibits diving within nine miles of the shore.

No one has ever succeeded in making a satisfactory substitute for a sponge. Sponge rubber is only partly satisfactory. Du Pont makes a synthetic sponge. Another attempt to get around the no-sponge situation is the use of a fibrous material called loofah. Small cuttings and cull sponges are bunched together and sewed inside a loofah cover, the whole being then used as a sponge is used. But a sponge is still a sponge and nothing has taken its place.

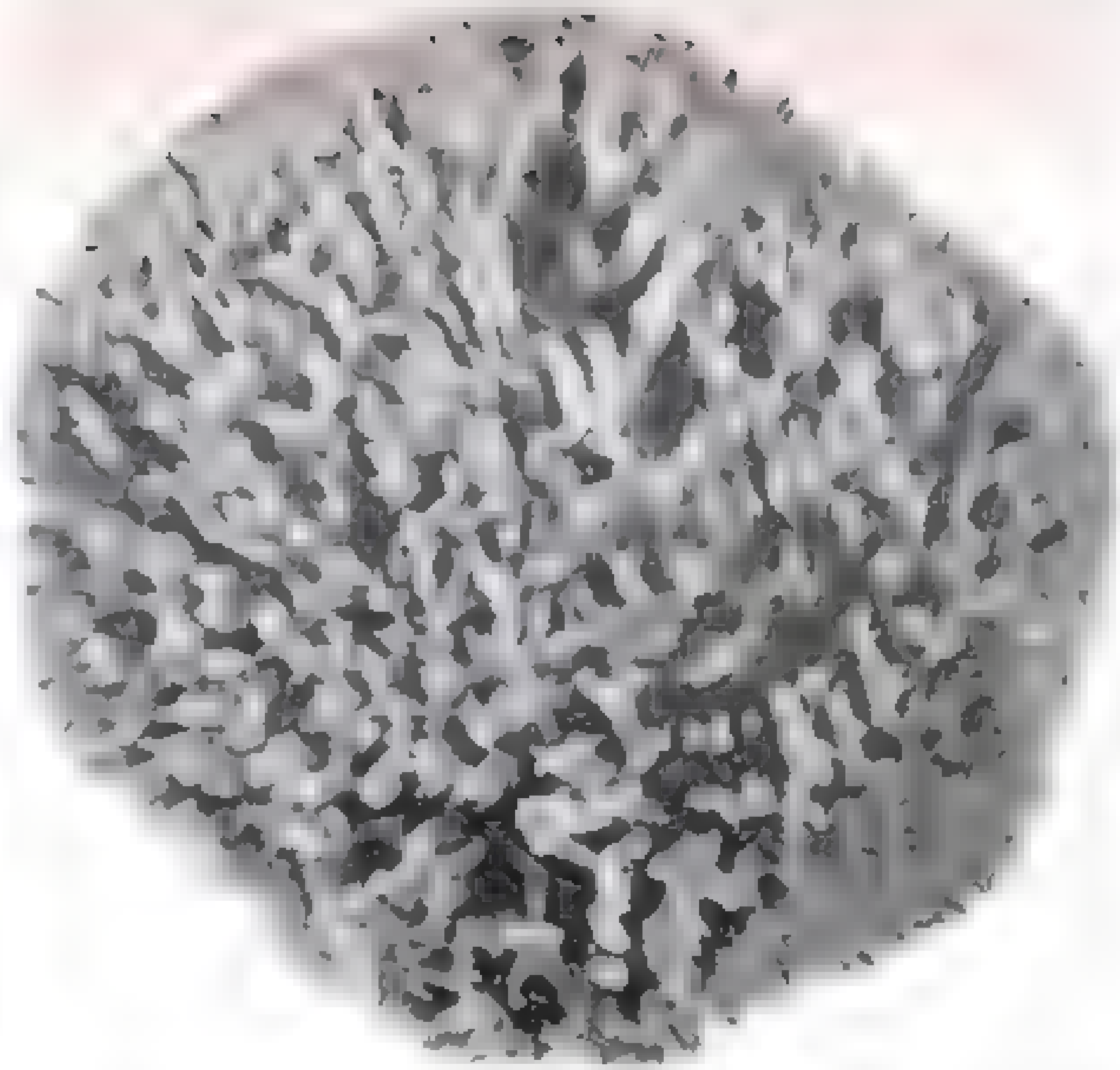
SPONGES VARY IN THEIR QUALITIES AND USES



ROCK ISLAND SHEEPSWOOL
Used for heavy-duty work, has great absorbency



FLORIDA GRASS
Cheap sponge used for general household work



CUBA SHEEPSWOOL
High-grade sponge for heavy-duty work

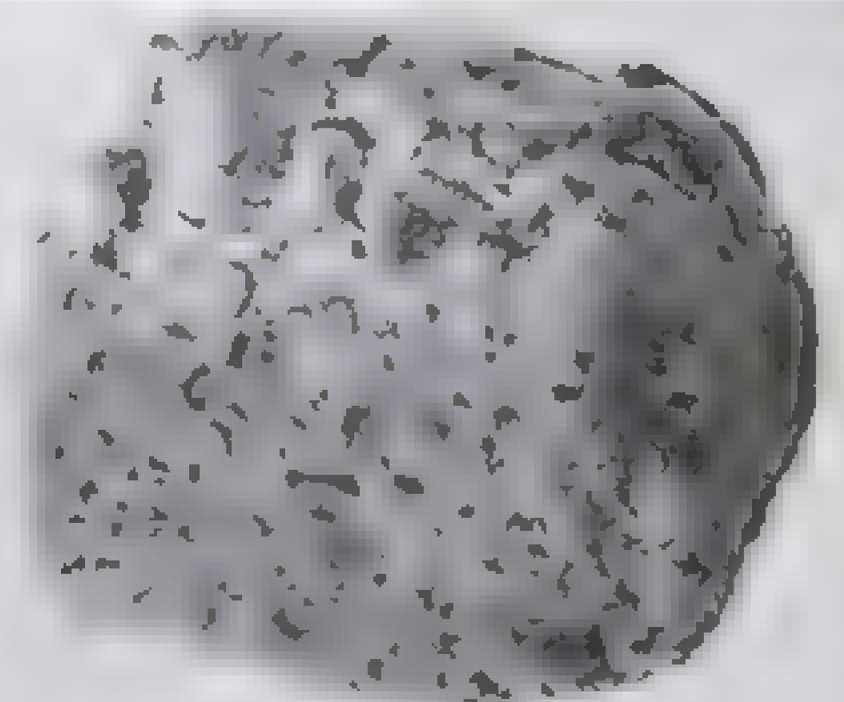
Man simply cannot duplicate Nature's design. Believed for centuries to be a vegetable plant, a sponge is really an animal—of infinite interest to the scientist because it is the lowest form of life that has more than one cell. It is a natural filter of infinitely complex pattern. From a purely mechanical standpoint its design is so perfect that it can still perform its filtering function after it is dead, stripped of its body, cleaned, and trimmed.

In life, a sponge works like this: Through hundreds of thousands of mostly invisible holes it sucks sea water into its body. It filters this raw material through a maze of perforations, tunnels, and tiny projecting spicules, extracting nourishment to feed the growth of its skeleton, which, stripped of everything else, you buy. There are sponges, like the glass sponge and the horse's-tail sponge, which have skeletons of nearly pure glass. But the commercial sponges contain no silicates. Their skeletons are *spongin*, a horny, organic substance whose chemical formula (C[illegible]H[illegible]N[illegible]O[illegible]) is close to that of silk.

The sponge is one of the most voracious of living creatures. Every time it adds an ounce to its own weight it swallows a ton of water. Having filtered out everything it needs for its growth, it expels the water, plus the waste of its digestive process,

HERE ARE SOME IMPORTANT COMMERCIAL TYPES

SILK SPONGE
High-priced, soft, used in surgery



FLORIDA YELLOW
Like Florida grass is used for general household work

through a series of large vents, the holes that you see when you look at a sponge.

The filtration process is perfect. That's why, when you take a spongeful of dirty water and squeeze it dry, the sponge is as white and clean as the day you bought it. An artificial sponge may suck up the impurity, but it falls down on the job when it comes to getting rid of it.

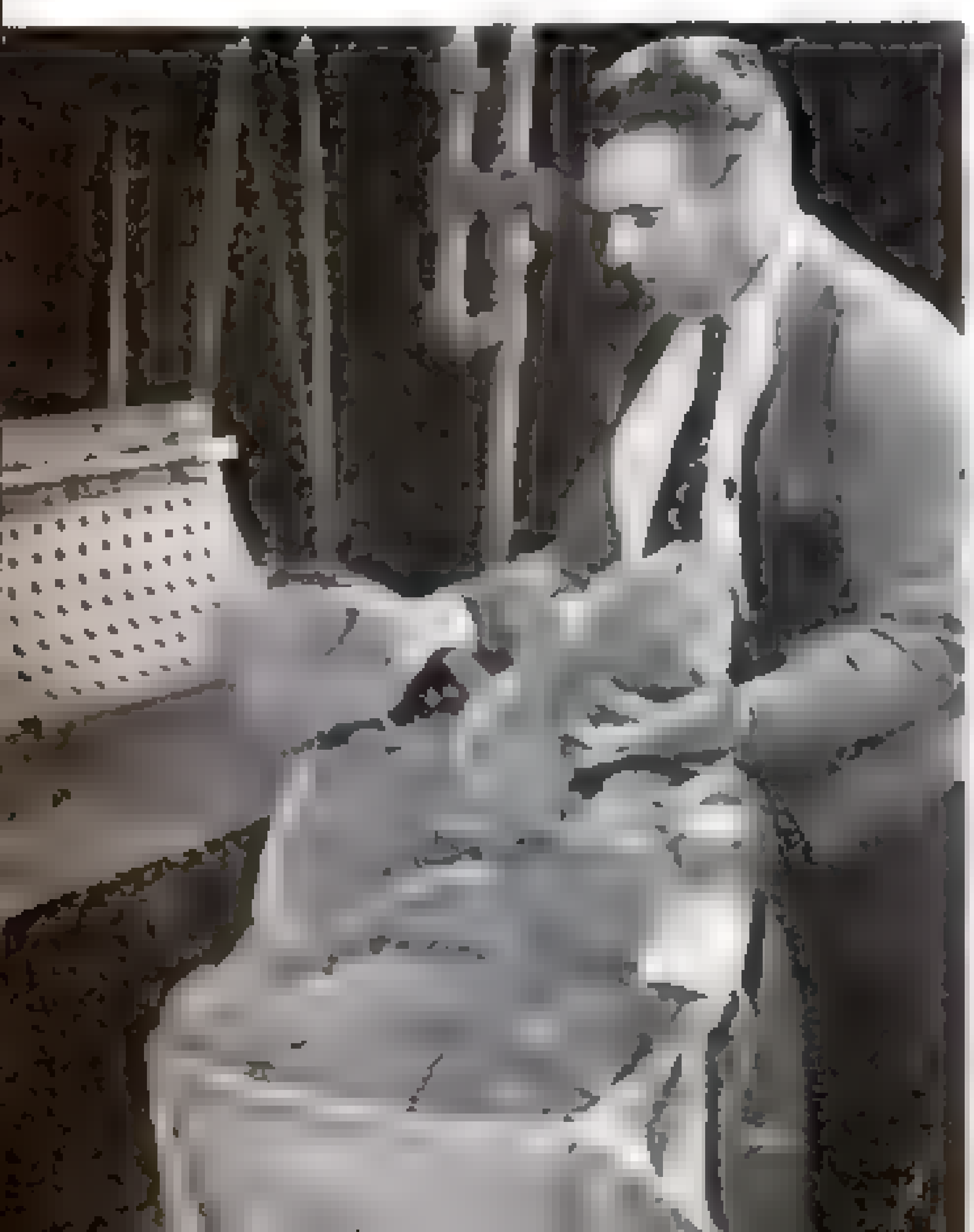
Sponges attach themselves to rocky formations at the bottom of the sea, where they become living tenements populous with crabs and shrimps. An infant sponge may travel for thousands of miles, borne by ocean currents, before it comes to rest. But once it fastens itself to the rock and starts growing it never moves from that spot again. The growing process may last for years and sponges grow to prodigious size. Hammerhead sponges off the Florida coast are commonly four or five feet across.

On the Atlantic seaboard, sponges can be found as far north as Cape Cod. But only a few useful types are fished commercially and these are all found between Lat. 30° N. and Lat. 30° S. Among these the "elephant's ear" of the Mediterranean is one of the most prized. Of American sponges, the Matecombe sheepswool sponge brings the highest price.

For centuries the industry centered in the Mediterranean. But recently the center of the industry has shifted to the waters around Florida, Cuba, and the Bahamas. In the last good sponge year, 1938, this area produced four times as much as was fished in the entire Mediterranean. The Bahamas accounted for the greatest amount, though Florida ran them a close second. But the Bahaman beds were being rapidly fished out, so 10 years ago the Nassau fishermen decided to try a basic innovation in sponge fishing: cultivation of sponges in the only place a sponge will grow—on the ocean floor. They would bring up a live sponge, cut it into small pieces, each containing an "eye" or "seed." Each seed was then either tied to a concrete weight and dropped overside, or staked to the ocean bottom by men in diving rigs. Earlier sponge-culture attempts were commercially unsuccessful. But this experiment was highly successful.

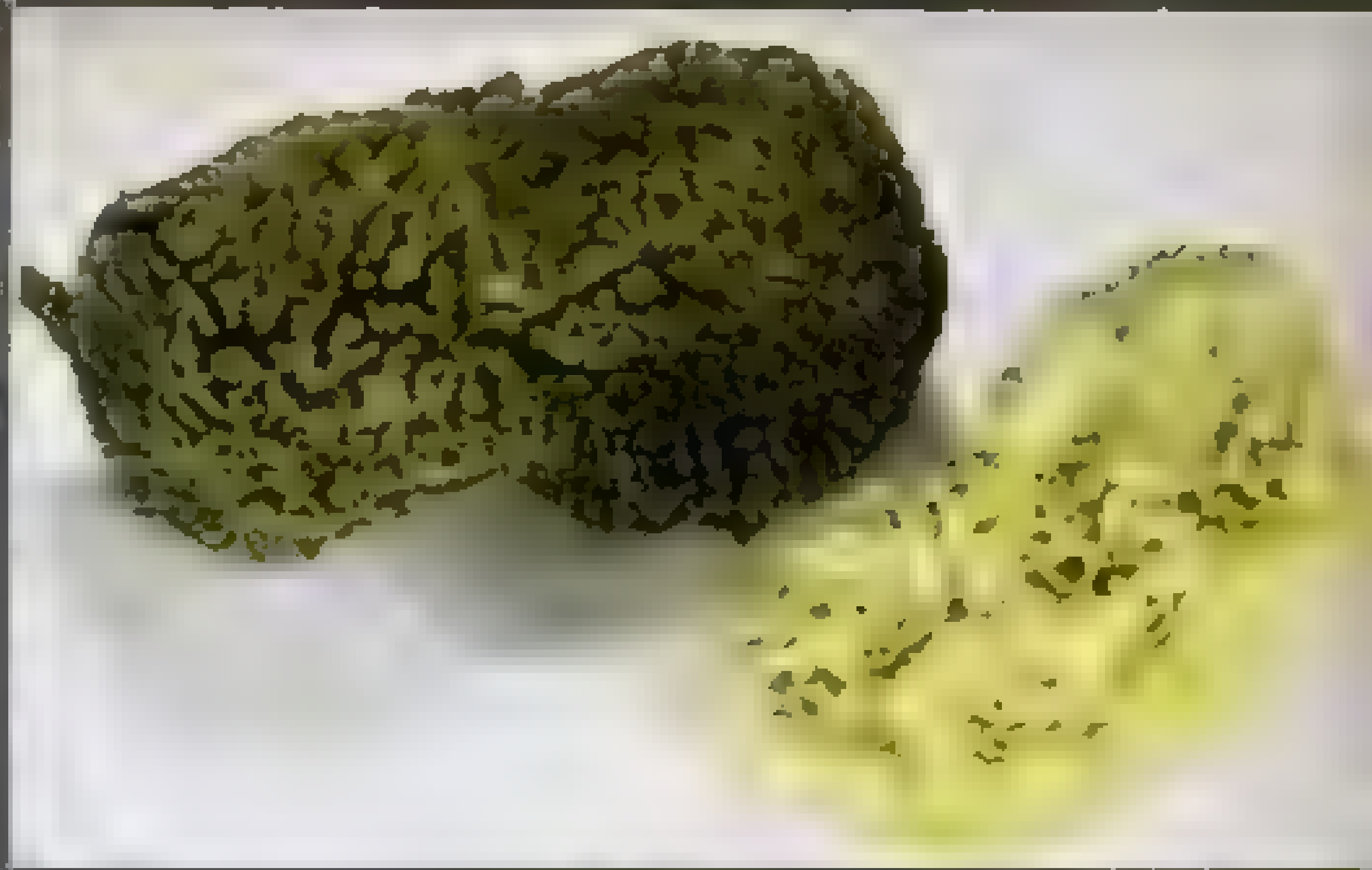
Sponge farmers had produced about 5,000 cultivated sponges, perfect in size and shape, when the blight set them rocking on their beam ends. The British Colonial Government stepped in and closed down the beds to save what was left; unfortunately it takes upwards of two years for a sponge to grow to commercial size. Off Andros Island, natives still defy inspectors, sharks, and man-killing barracuda and go after sponges by "skin-diving" the way Mediterranean divers did centuries ago. With a knife clamped between his teeth and a net bag at his waist one of these dusky descendants of the buccaneers can dive as far as 100 feet and stay down for unbelievable lengths of time.

Much more modern though no less daring are the divers of the Tarpon Springs fleet. Today the United States, by far the world's biggest user of sponges, depends entirely on the output of this one village of 3,400 souls on the west coast of Florida. And the divers that work out of Tarpon Springs, curiously enough, are all Greeks.

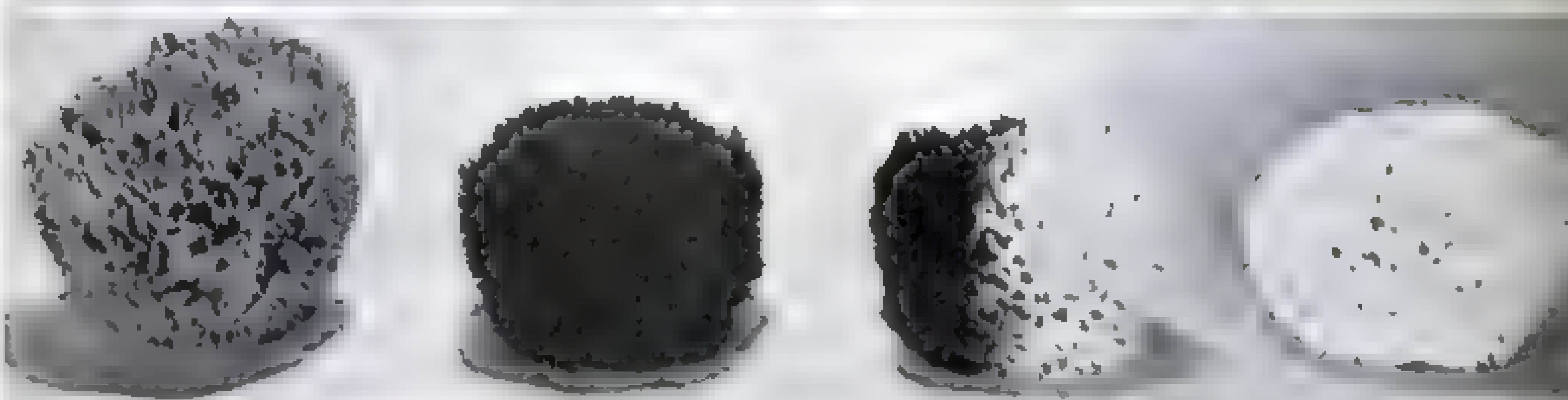


A 50-pound bale of Rock Island Sheep's Wool sponges, left, starts through a treating plant. The sponges first are put into an oscillator or rotary washing tank to remove external dirt, sand, and impurities

Below, the sponges are then immersed and soaked in a solution of potassium permanganate until it has thoroughly permeated them. This softens the fibers and prepares them for the bleaching-out process



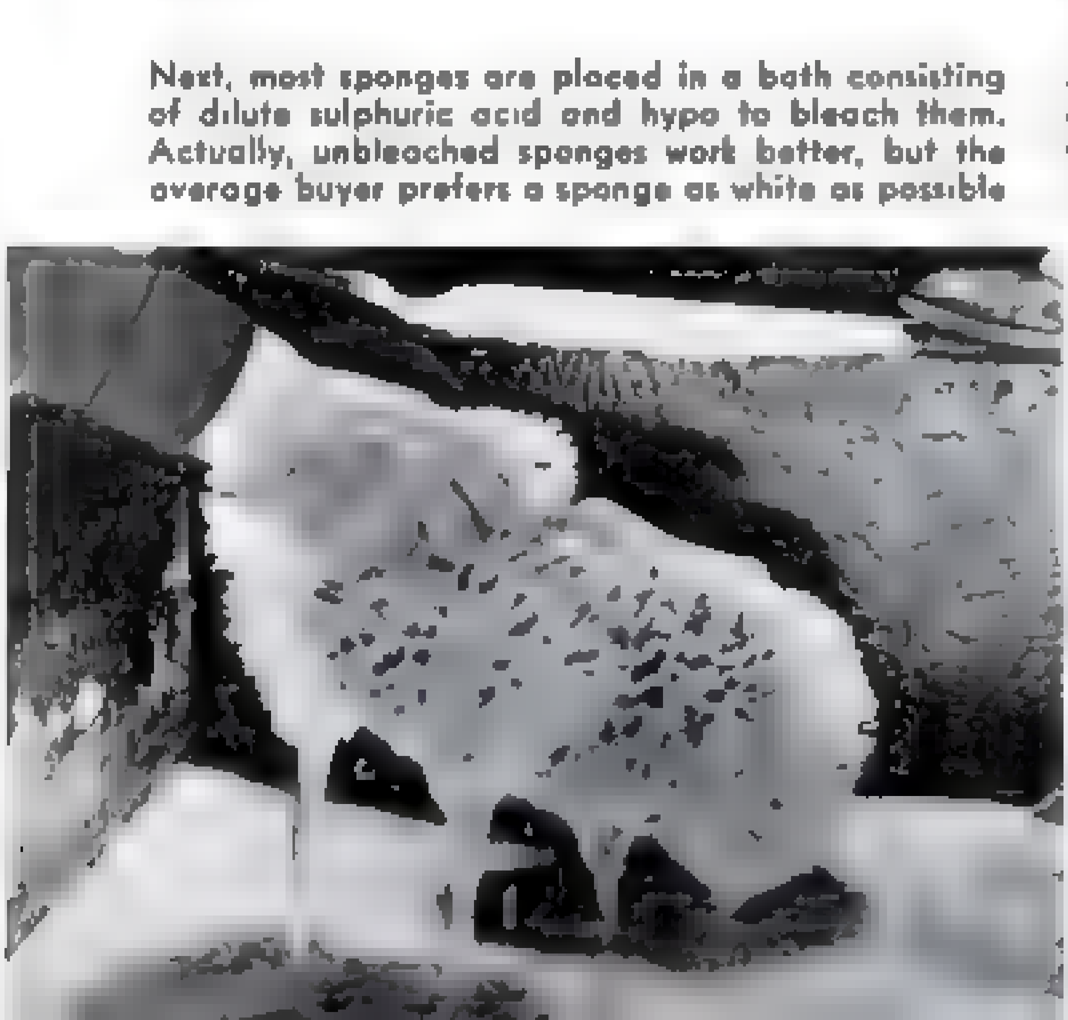
There's a big difference between a sponge as it comes from the sea and the clean, light-yellow sponge you are used to seeing. Washing and bleaching does the trick, as shown below, left to right: washed, dipped in potassium permanganate, half-treated with acid, and completely bleached.



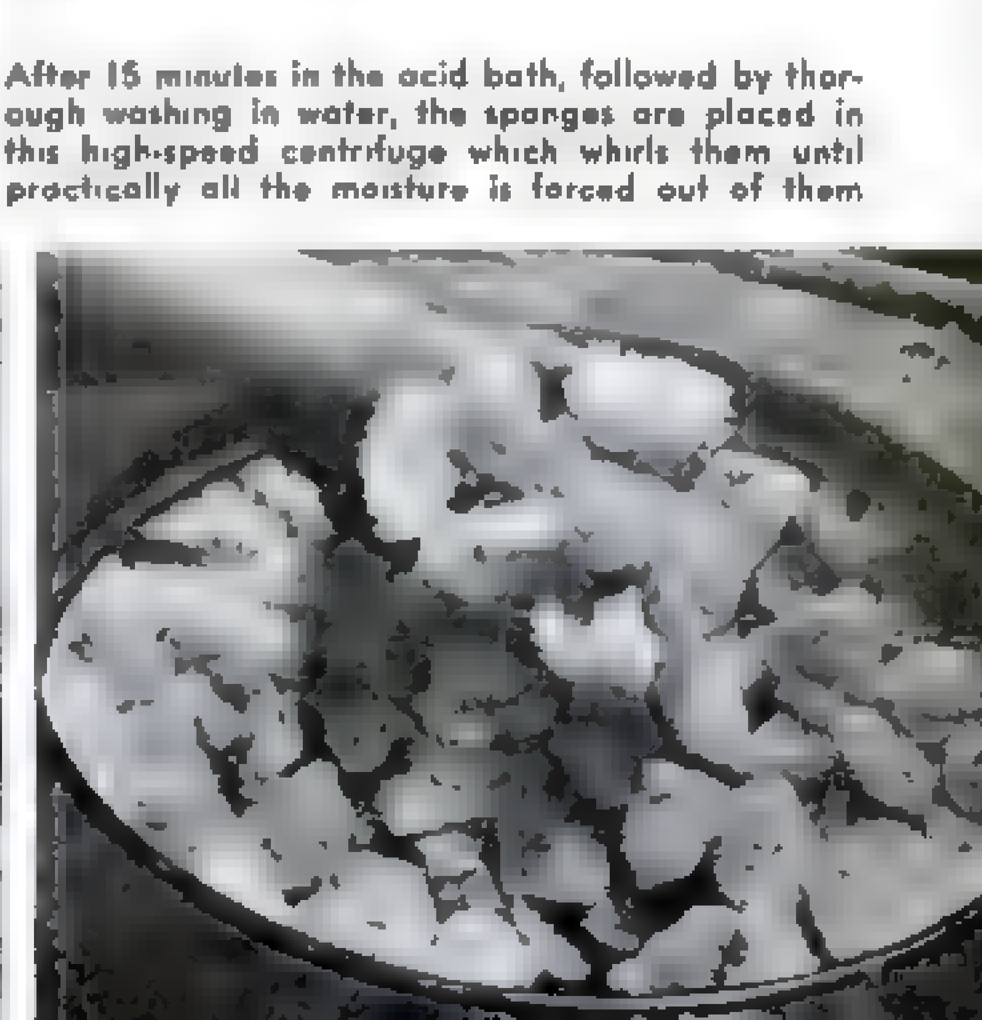
They work in suits especially manufactured to their specifications, on the same general pattern as the rigs used by the U. S Navy but lighter, with less weight on the feet. Working for an hour or longer at a stretch, 150 feet down in waters infested by man-killing barracuda, these fearless divers need plenty of freedom to move around among the tangled growth of the ocean floor.

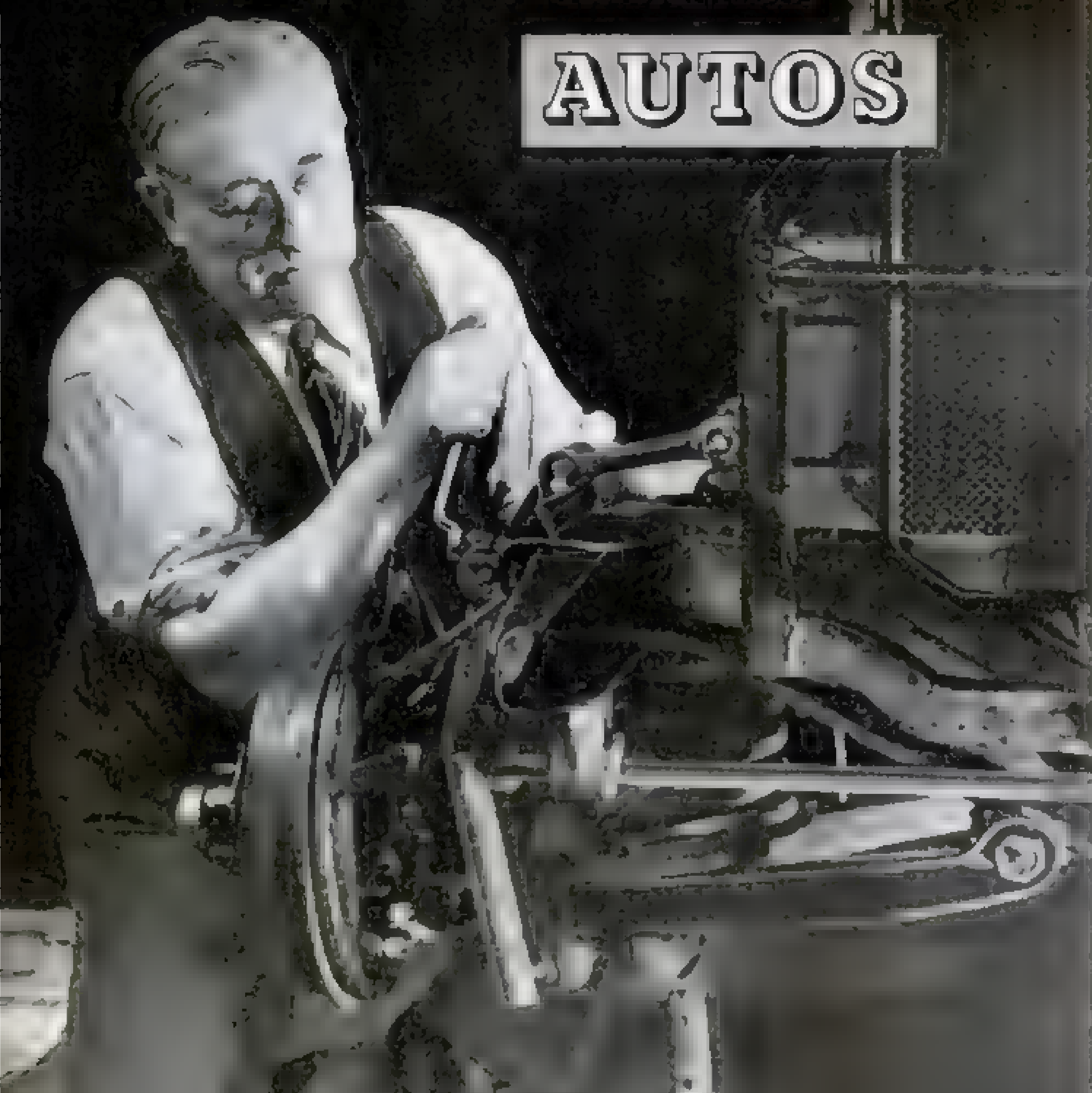
Their hands are bare to feel their way among murky pinnacles of coral, and to wield the three-pronged hook that tears a sponge from its moorings without damage. Though they have improved the design of their diving rigs, the Greeks still sneer at new fandangles like the decompression chamber. They declare that softies who acquire the "bends" have no business messing around on the ocean floor.

Next, most sponges are placed in a bath consisting of dilute sulphuric acid and hypo to bleach them. Actually, unbleached sponges work better, but the average buyer prefers a sponge as white as possible



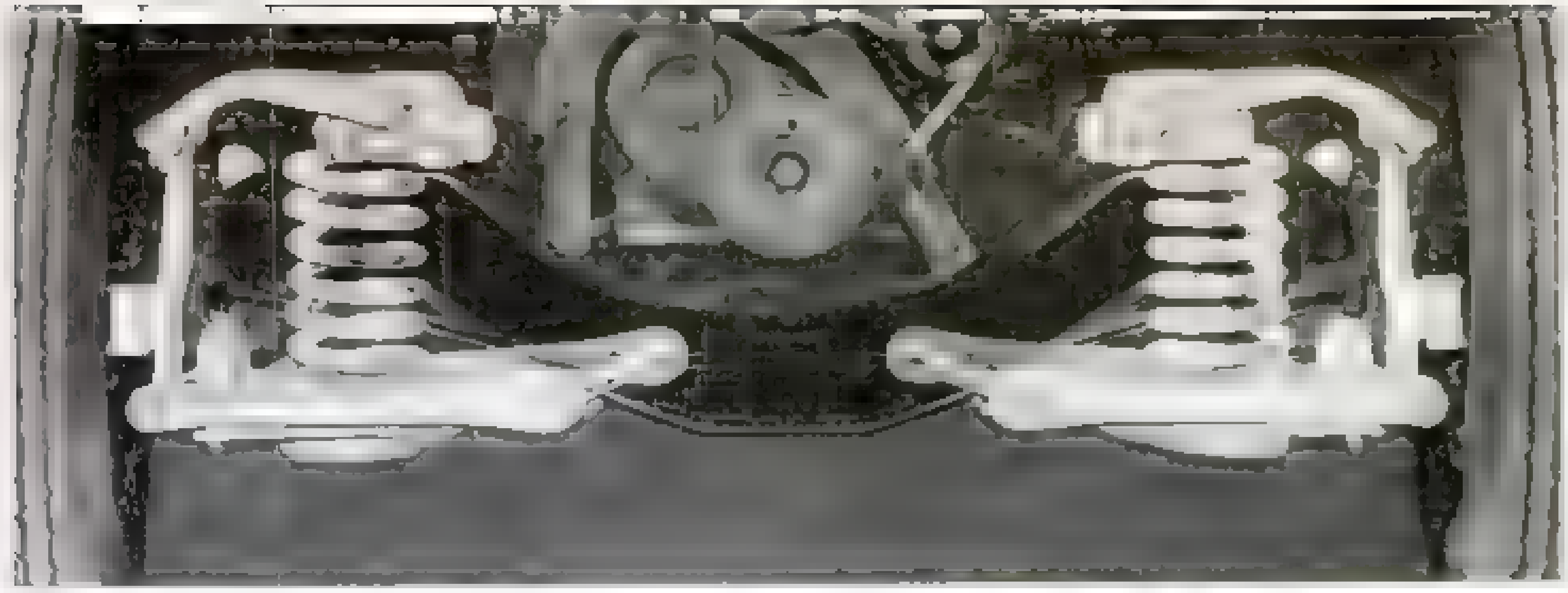
After 15 minutes in the acid bath, followed by thorough washing in water, the sponges are placed in this high-speed centrifuge which whirls them until practically all the moisture is forced out of them





Preparing to service the shock absorber on a knee-action coil spring unit

Springs and



At top of page, a phantom view of a conventional knee-action front end reveals its basic mechanism. Note that the upper control arms actually are hinged on the shock absorber. Lower photo compares a lightweight coil spring and old leaf spring

By SCHUYLER VAN DUYNE

TIME was when all cars rode like trucks. Then care of their springs was as important to uninterrupted motoring as keeping gas in the tank. Metallurgy and the exhaustive research of proving-ground technicians have remedied troubles such as stiffness, breakage, squeaks, and rattling, but unfortunately a few potential troubles remain. And when car building stopped last winter, there had not yet been developed a practical way of permanently lubricating the running gear that limits spring-governed motions of cars in relation to their wheels. Regular greasing was still up to the motorist, who rarely attended to it after the first flush of new-car pride wore off.

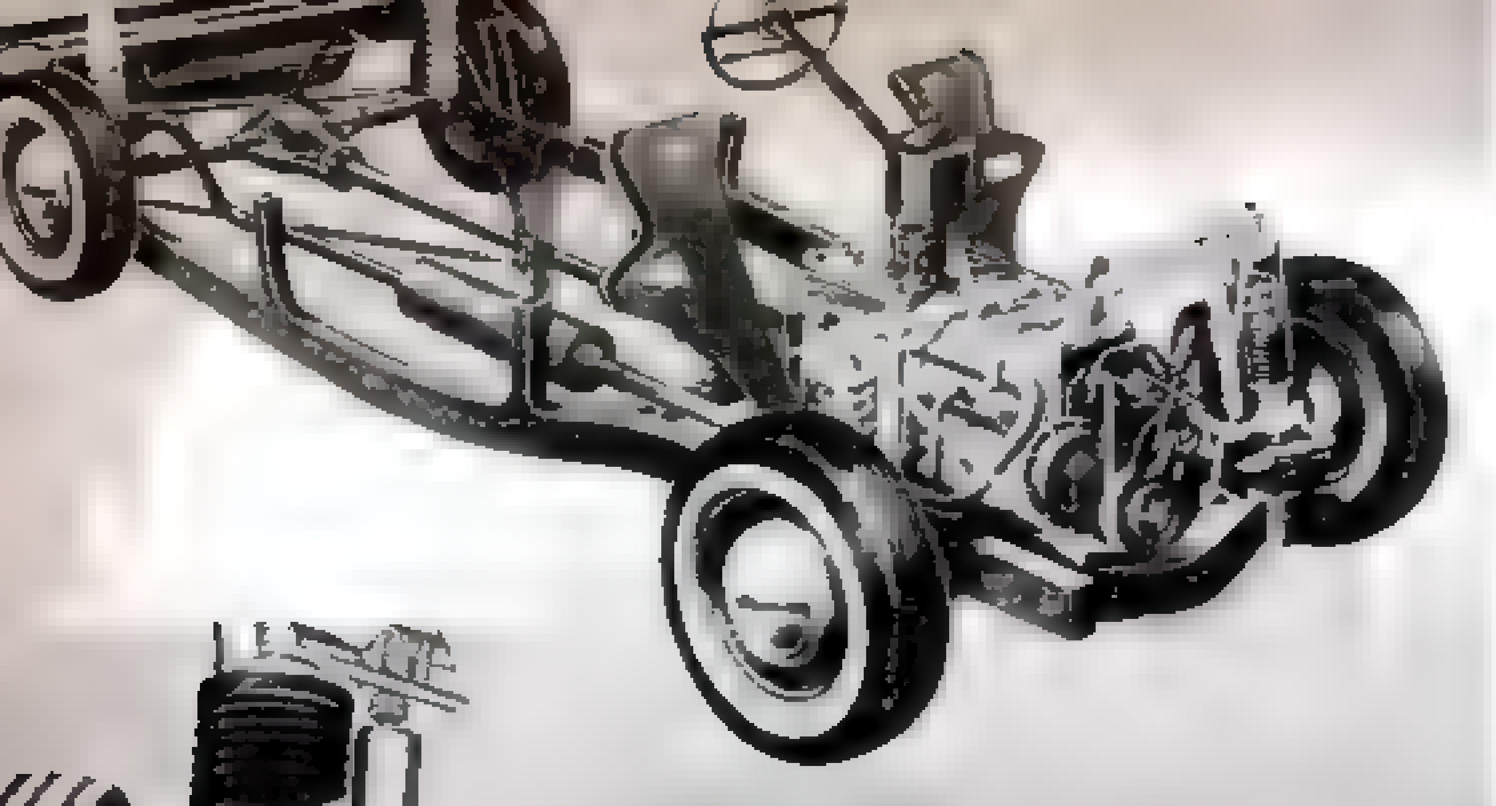
Nearly all recent-model cars use coil springs in front; three use them in back, too. Coil springs are lighter and more flexible than old-fashioned leaf springs for the same car. This is because a coil spring is easily adapted to serve simply as a compression spring, whereas the old-style leaf spring also served as thrust block, torque rod for drive and brake forces, and side-sway stabilizer; as well as a steering-gear bracer at the front end of the car. Exceptions are the transverse leaf springs on front ends of modern Ford and Studebaker-built cars which are mounted much as knee-action coil springs are and therefore likewise serve simply as compression springs.

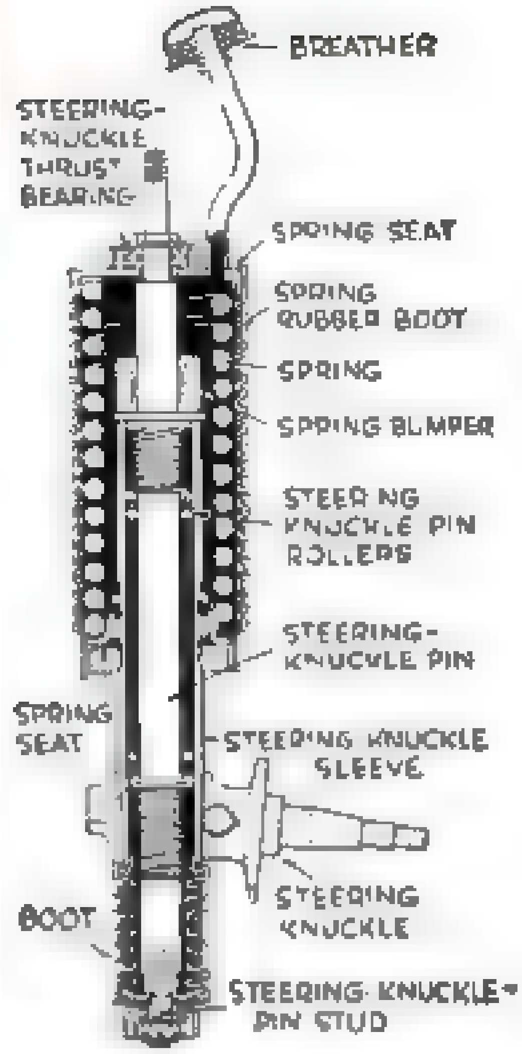
While many modern cars still have leaf springs at the rear, most of their former duties are taken over by new mechanical linkages. So nowhere do we find today the stiff, heavy leaf springs that made grandfather's jallopy ride like a truck.

For front ends, a hinged affair resembling a parallelogram, called knee-action, makes coil springs practical, and the metallurgist's skill made possible the knee-action's light, tough parts.

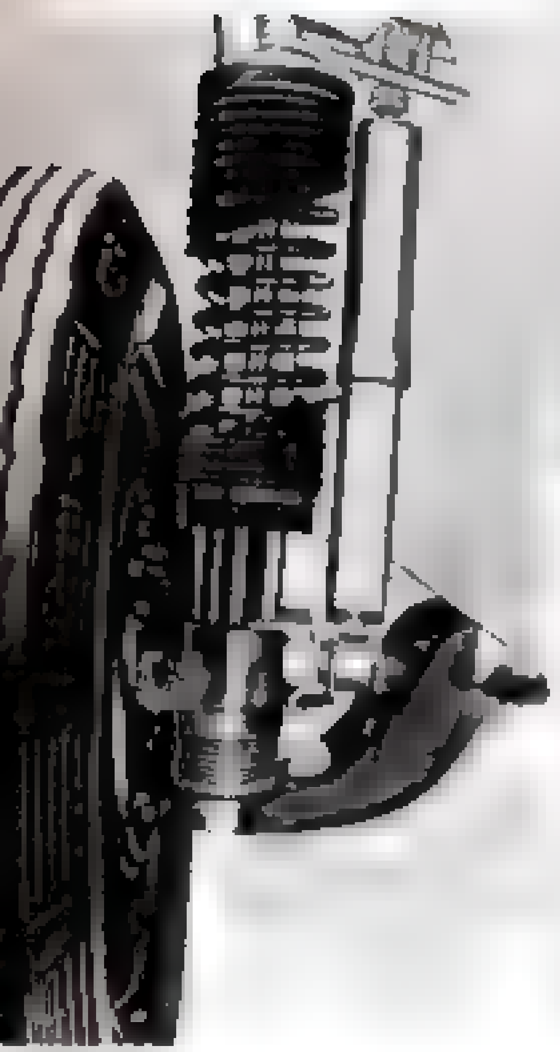
An unusual front-end, coil-spring suspension was introduced recently by Nash. Patterned somewhat after a principle long used on foreign cars, the system actually has an oversize kingpin on which the steering knuckle may slide up and down as well

Their Care...





Coil springs on all four wheels, common to several modern cars, here take an unusual form. The front coil springs inclose the king pins on which steering knuckles slide up and down to accommodate road bumps, and also turn to permit steering the vehicle



Left, close-up of same front-end unit with spring boot cut away. The ever-present shock absorber connects between the steering knuckle and tie rod at the top. In the rear spring at upper right, note how the airplane-type shock absorber is inclosed by spring itself

as swivel. A coil spring between a seat on the knuckle and one on the top of the king-pin carries the weight of the car and is free to compress and expand with this weight.

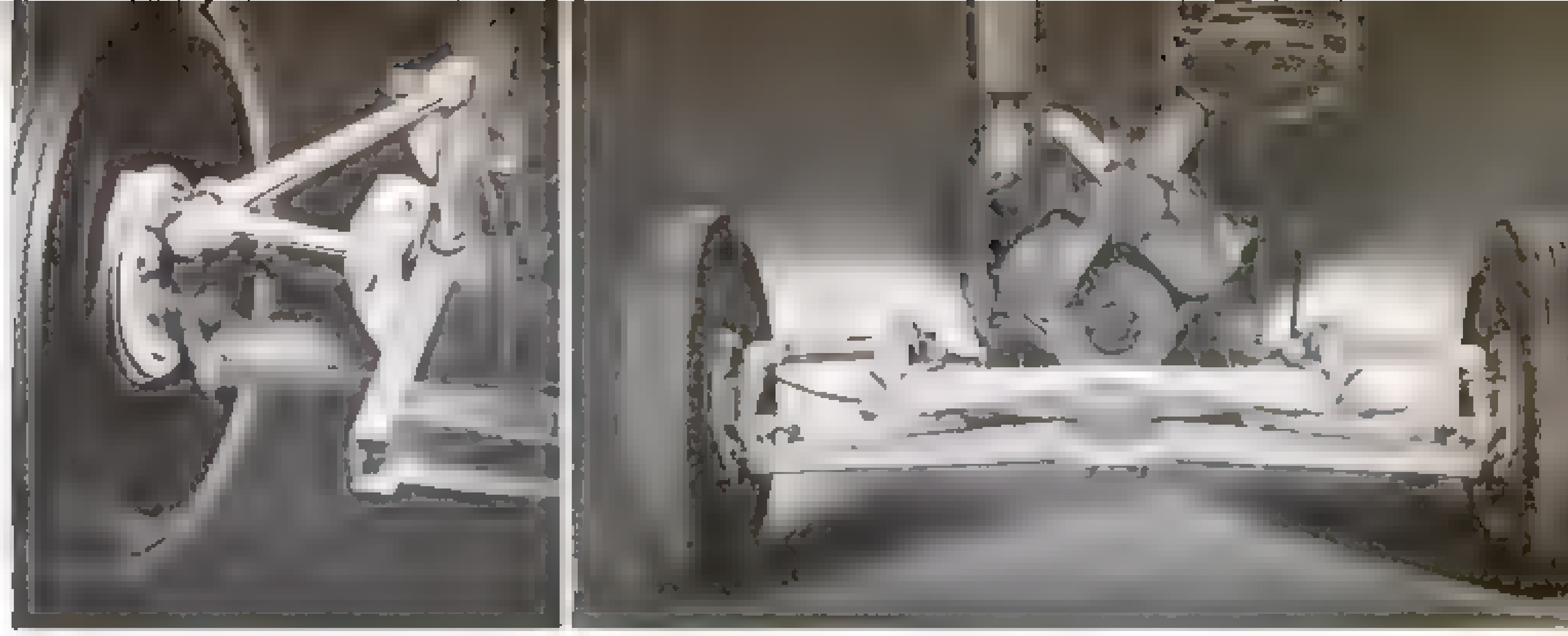
Just as leaf springs demand lubrication of the shackles connecting them with the car chassis, so knee-action parts that allow the coil spring to flex must be lubricated. Without lubricants, they wear rapidly. And it is here that the most serious troubles may occur. For every motion between front wheels and frame is determined by or dependent on their perfect operation. Looseness and misadjustment caused by wear between the linkages will affect car comfort, quietness, and economy. Even more important, they will upset the delicate geometry of steering apparatus. This in turn can cause excessive tire wear, shimmy, wheel tramp, poor steering, car wandering, and a host of other driving troubles and dangers.

While a coil spring may be broken, you will nearly always find that a faulty shock absorber permitted the damage because of unrestrained compression and rebound of the spring. Even at that, the chances are slim, but you should certainly include the care of shock absorbers under the heading of spring care.

There have been many variations in design of shock absorbers, but since the late 1920's all have been hydraulic, pumping uncompressible oil through valves of small aperture to retard the speed of spring movements. At first, they controlled only spring rebound. But cars still pitched like hobby horses on rough roads, so double-acting hydraulic shock absorbers became virtually universal, controlling compression over all

SHOCK ABSORBERS PREVENT SPRING

[illegible] knee-action unit's spring or shock absorber, the knee action must be dismantled. Here a mechanic loosens the clamp bolt of the steering-knuckle support on upper control arm



Two views of the planar or transverse leaf-spring installation employed by Studebaker. Ford uses the same type of spring but adds a full-length axle. Note the two single lower control arms here and the wishbone type upper control arms. Net effect is similar to that of conventional knee action. In any such suspension, spring care consists mainly of lubrication and good servicing of the shock absorbers

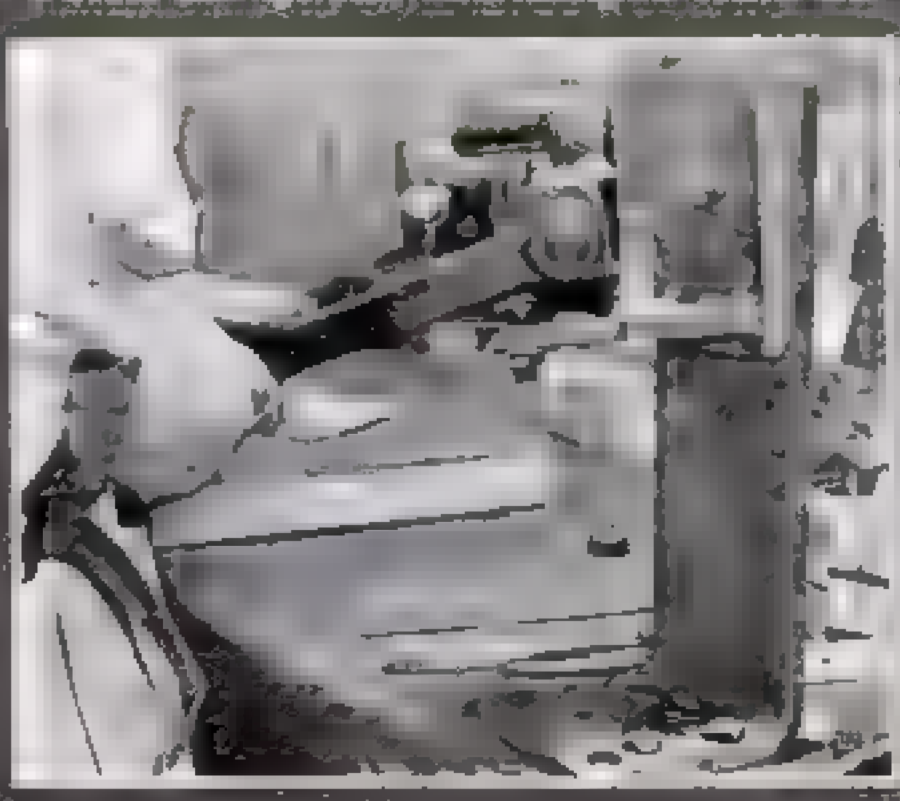
but the most violent bumps, when a safety valve opens to prevent breakage, and limiting rebound as well.

The double-acting hydraulic shock absorber may be either indirect or direct acting; that is, the pistons which push on the oil may be operated by levers and cams, or directly by the relative movement of the chassis and axle. The latter type, sometimes called the airplane type, looks like a rolling pin with loops at either end. Its single piston has two-way valves, and actually operates back and forth in a single cylinder, which is two cylinders in effect. The former type looks like, and is remarkably similar in principle to, those big arm-and-lever door checks often seen on heavy doors.

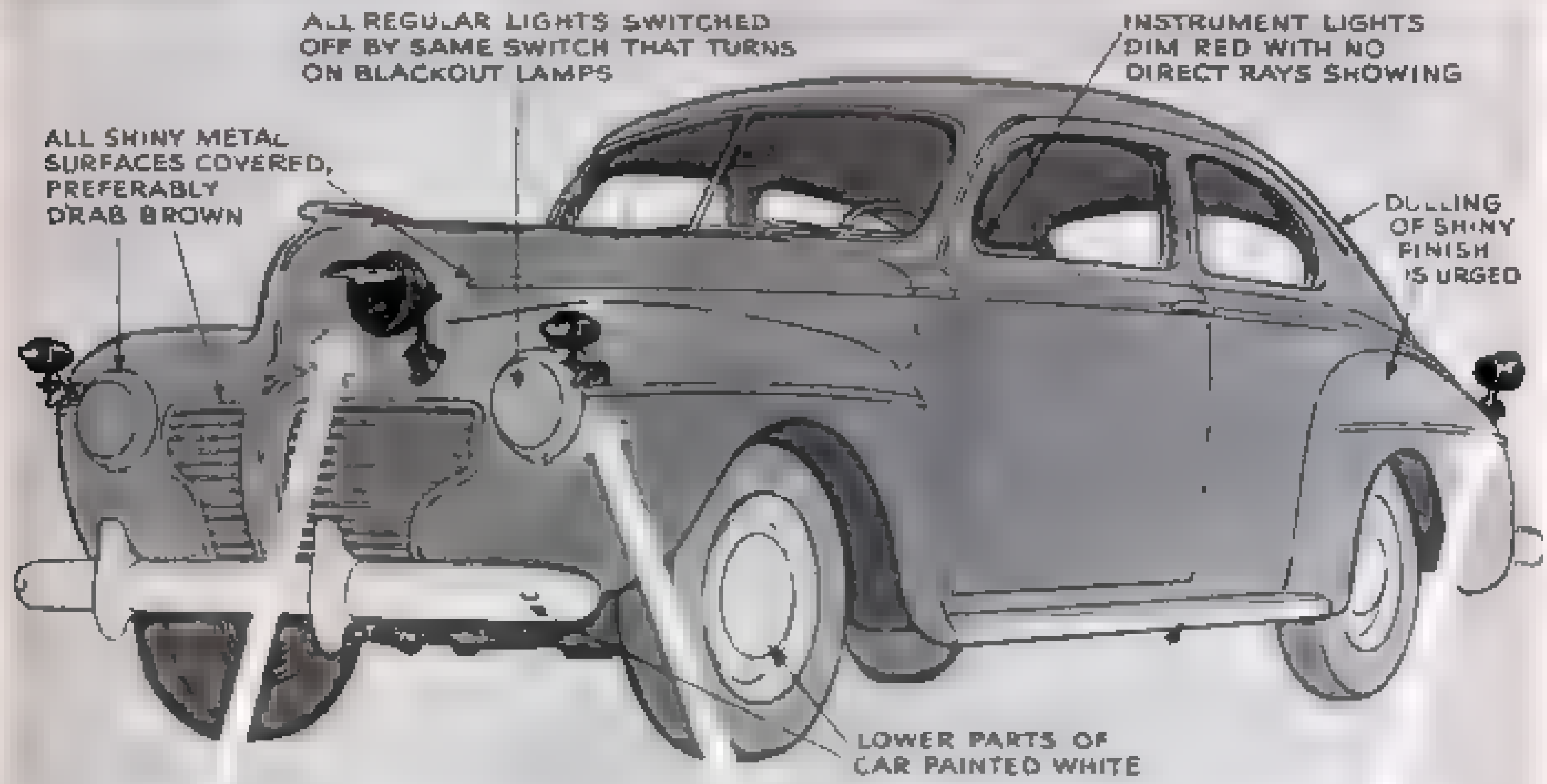
Fluid should be added to shocks at least every 10,000 miles, at which time they should be checked for leakage, noise, worn or broken links or bushings, and proper action. A good check on action is obtained by bouncing each corner of the car. If the corner continues to spring up and down when you let go, its shock absorber is in need of service.

Of prime importance to spring life is lubrication of the mounting arms that regulate wheel motion, their levers, yokes, and other jointed units where lubricant fastenings appear. Your car instruction book is the best guide to lubrication frequency Plain leaf springs, covered or not, need proper oiling, too, to permit unrestricted motion. Attend carefully to lubrication and to shock absorbers and modern car springs will give you little worry. Neglect will lead straight to serious trouble

BREAKAGE. YOU MUST KEEP THEM WORKING RIGHT

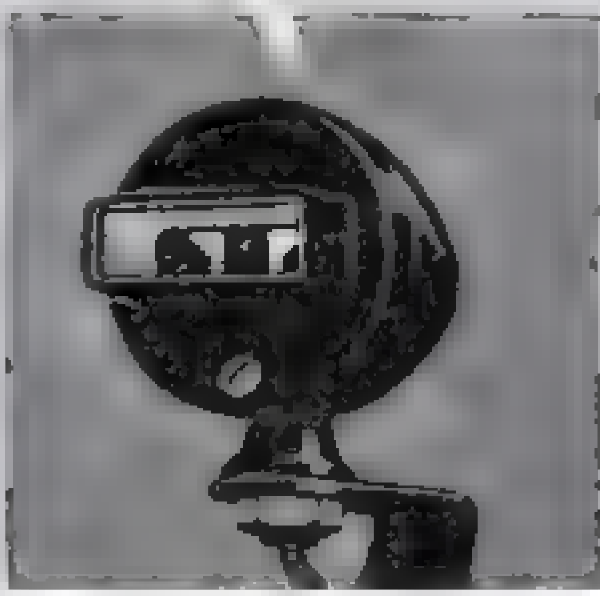


Blackout Road Rules



THE THREE LAMPS APPROVED FOR BLACKOUT USE ON AUTHORIZED CIVILIAN VEHICLES

DRIVING LAMP. One at front between center and side of car



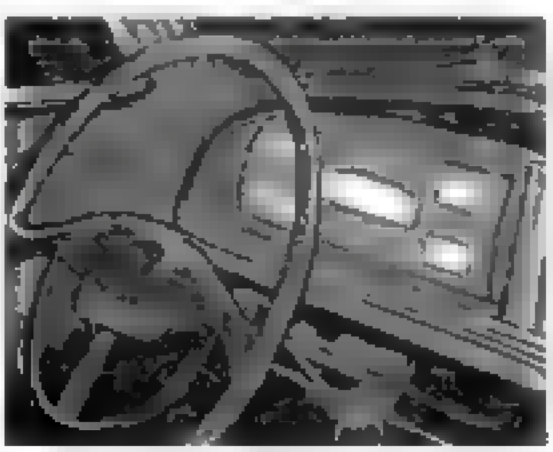
CLEARANCE LAMP. One at each side of front of vehicle

TAIL AND STOP LIGHT. One; two if vehicle is 80" or wider

IF YOU are authorized to drive during a blackout from now on, your vehicle must carry the special new blackout lights just approved by the War Department. The lights consist of a driving lamp and two clearance lamps for the front, and a combination tail and stop light for the rear of each motor vehicle. If you ride a bike, push a cart, or drive a horse, required equipment is specified for them, too. And every authorized vehicle must be prepared in advance so that its bright metal work is dulled, shiny surfaces covered, and, in some cases, it is equipped with approved reflector elements properly attached.

A recent War Department specification tells how the lights and permissible marking devices must be mounted on private and commercial cars, trucks, bicycles, pushcarts, ambulances, horse-drawn vehicles, and practically everything on wheels. And it warns frankly what the well-dressed pedestrian should wear when, and only when, duty or necessity compels him to venture abroad during a blackout.

Pictures and many details of the three new approved lights are being withheld by the War Department as capable of giving aid to the enemy. But permission was given to POPULAR SCIENCE to show, in the illustrations above, its conception of them, as



DASH LIGHTS must be dim red or out; automatic lights inoperative with blackout lights on

WAR DEPARTMENT SPECIFICATIONS TELL WHAT LIGHTS TO USE; HOW AND WHEN TO USE THEM

drawn by its own artist from information that has been released.

You probably won't be able to buy the lamps for some time, since the output of several manufacturers is going to the Government. Until then, there are no other officially approved blackout driving lights. Cooperating with the War Department in drawing up the specifications were the Army Engineer Board, the National Technological Civil Protection Committee, the National Defense Research Council, the U. S. Bureau of Standards, the Interstate Commerce Commission, the Office of Defense Transportation, and the War Production Board.

The main driving light has a hood projecting out over its large black mask. A lens fitted under the hood forms a horizontal light slot, flat on the bottom but with several short vertically extending slots along its upper edge. The hood permits from 25 to 50 candlepower to be projected on the road, but cuts this value to .005 candlepower one degree above the horizontal—virtually invisible from a few yards away. A pair of standard sealed-beam headlights throw 50,000 candlepower on the road.

It is for use on all motor-driven vehicles, including streetcars, busses, trolley-busses, and motorcycles. On all but the last it is mounted between the left side and center. Motorcycles carry it center-mounted. It must be far enough forward to eliminate objectionable reflection from the vehicle itself, as near as possible to the normal line of the operator's vision, and between 36 and 55 inches above the road in a normally loaded vehicle, but no higher than the top of the steering wheel.

Mounting calls for critical adjustment so that the slot is level and the beam projects straight forward.

BICYCLE. Amber reflector at front, red, rear. Whiten lower parts. Blackout flash is urged

MOTORCYCLE. Driving and one clearance lamp front; tail-stop rear. Dull all shiny areas

ANIMALS. Use blackout flash or lantern to reveal them. Reflectorize wagons same as bikes

The visual cutoff of the top of the beam on a vertical screen 10 feet in front of the lens must be between two and three inches below the bottom of the slot.

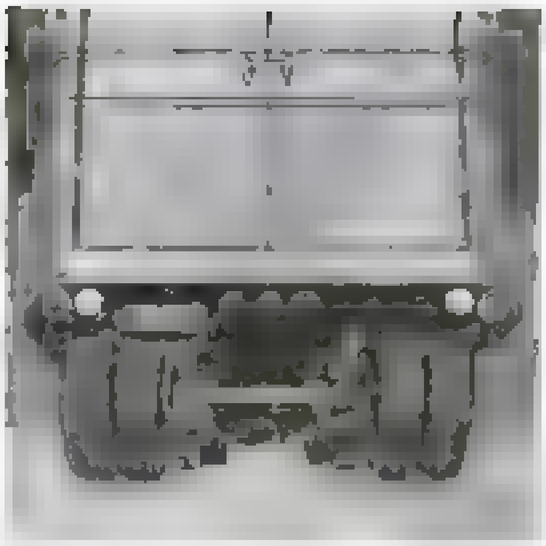
The clearance lamps—a pair to each motor vehicle except motorcycles, which have one—show white for emergency vehicles only, amber for all others. Smaller than the driving light, they are securely mounted as near to the sides of the front of the vehicles and as close to the headlight level as possible, without interfering with the function of the headlight. Aimed straight ahead with the face of the lens vertical and the slot horizontal, the lamps shine with the driving light to show the width of a vehicle. Motorcycles use just one clearance lamp at the front center.

Casting no usable light on the pavement, the clearance light has a rectangular hood with a lens over the front end and a light-absorbing inner surface. The hood, about an inch long, carries a light mask at its back consisting of two more-or-less triangular lenses with the apex of each triangle pointed down. Thus they appear brightest from straight ahead, the brightness diminishing to zero as the viewing angle rises. They can be seen from about 1,000 feet dead ahead.

The approved combination tail and stop light is to be mounted close to the left rear of the vehicle. Its red tail-light lens goes at the bottom, its amber stop-light lens at top. The light openings are recessed in the housing. Recessing gives the same effect as a rectangular hood.

The masked opening of the tail-light unit takes the approximate shape of four V's lined up beside each other, with a wide space between the two center ones giving the appearance of two separated pairs of V's to the lineup. From some

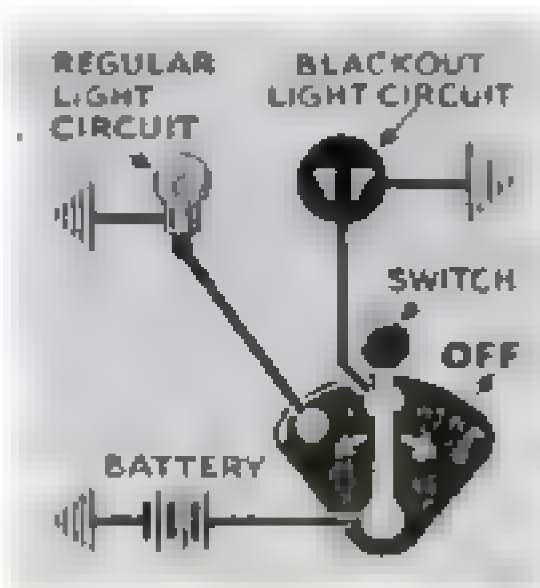
distance away, the four V's blend to the eye so that they appear as a single red glow. Closer, the outside pairs of V's appear as two distinct glow spots. Still closer, all four V's appear distinctly in their separate positions. Thus the tail-light lens is at once a warning of the presence of the vehicle and a gauge of its distance from the observer.



WIDE MOTOR VEHICLES. Extra tail-stop lamp plus special reflectors at sides, rear, front

The clearance lights forward display a similar, though modified, distance-gauging effect with their two small openings. It is of less importance, however, since the two lamps themselves furnish the eye, accustomed to judging perspective, with ample distance information.

The War Department says that the blackout lights must have their own separately fused wiring systems controlled from a combination master switch that turns off all regular lights when the blackout lights are turned on. It must also turn out both sets of lights in its "off" position. Instrument lights are an exception. They may remain lighted if they provide only dim, red, indirect illumination, though you will see better by putting them out. Directional signal lights, normal stop lights, and others that are manually operated must be made inoperative and never used during blackouts.



SWITCH puts out normal lamps as it turns on blackout lamps. Also puts out everything

Vehicles 80 inches or more wide must carry extra combination tail and stop lights on the extreme right rear, balancing the left rear ones. Also, two approved red reflectors must be attached no higher than 30 inches on the extreme rear near the sides, as well as two amber ones at front near the sides. If over 35 feet long, a vehicle must also display low-mounted red reflectors on the sides near the rear, and amber ones on the sides near the middle and the front. Such side and rear reflectors are strongly recommended for all vehicles, as is flat-white or reflectorized paint on bumpers, hub caps, and lower portions of all vehicles. All shiny surfaces should be dulled, preferably with drab-brown paint.

PEDESTRIAN. Must wear white or reflectorized leggings: should carry approved flash or lantern

Streetcars and busses of all descriptions must carry approved driving, clearance, and tail-stop lights and specified reflector elements. Bicycles, the lowly push-cart, and other human-power vehicles must have approved amber reflectors on the front and red ones on the rear, and white paint on lower portions is urged. Approved blackout flashlights and lanterns—not yet announced as this issue goes to press—may supplement or substitute for the reflectors. Animal-drawn vehicles—even ridden or herded animals—must stay off highways unless protected with blackout flashlights or lanterns, displayed so the animals are visible to approaching traffic.

The special reflectors for use on the sides and ends of vehicles during blackouts are far different from plain colored reflectors and mirrors. Place two glass mirrors at right angles to each other and you can then see your own reflection in them from a wide, horizontal viewing angle. The blackout reflectors use this principle, but add an extra mirror for three-dimensional viewing. Thus, light striking them is reflected straight back to the source, but in no other direction. As a result, your own car's lights will pick out a reflectorized vehicle, but not reveal that vehicle to anyone else.

Individuals must stay off streets during blackouts. Necessity or official duty is their out. Then, they should wear white or reflectorized leggings, or anklets equipped with approved clear reflectors, and should carry a blackout flashlight or lantern. In lieu of leggings or anklets, white cloth should be wrapped around the lower legs. Finally, pedestrians should remember that under blackout conditions "they generally are not visible from moving vehicles." That's fair warning.
—SCHUYLER VAN DUYNE.

Gus sat on his bench and the rest of us made ourselves comfortable. "Cattle man, perhaps?" asked Knowles. "No, sir. Never had anything to do with 'em. Automobiles is my game. You bet!"

GUS has a visitor

And, as usual when one of Gus Wilson's old friends shows up, he brings along a yarn to swap with the Model Garage's mentor

By MARTIN BUNN

FOR quite a few years before Gus Wilson teamed up with Joe Clark and started the Model Garage in our suburban town he knocked around the country, holding down one automotive job until his feet began to itch, and then moving on to a new job in a new place. Being Gus Wilson, he made a lot of good friends. Every now and then one of them stops off in our town to visit with him and exchange reminiscences.

The other evening a few of us Model Garage regulars saw the lights burning in Gus's shop and decided we'd drop in for a little fanning session. A man who had a black ten-gallon hat on the back of his head was sprawled out in Joe Clark's private swivel chair and had his feet cocked up on Gus's workbench, and looked too much at home to be an ordinary customer.

"Hi!" Gus hailed when he saw us. "Glad you fellows stopped in. I want you to meet an old friend of mine, Sam Chivers—we were pals out on the Coast, years ago."

Sam Chivers took his feet down off the workbench and got up out of his chair. He was about six foot three and wide in proportion. His fashionably cut, double-breasted, gray suit didn't go with that ten-gallon hat. It didn't go with his tanned face, either nor with his frontier-model mustache. Gus

"'Hold it, Sam,' I said. Then I told him what was on my mind, and together we cut a yard or two of wire off one of the lines."

introduced us to him, and as he shook hands he said the same thing to each of us: "Glad to meet you. You bet!" Gus sat on his bench and the rest of us made ourselves comfortable.

George Knowles takes pride in being able to guess people's business from their appearance. "Mining man, Mr. Chivers?" he asked

"No, sir," Chivers told him. "Never had anything to do with mines, outside of buying stock in 'em and losing my money."

"Oh," George said. "Cattle, perhaps?"

"No, sir," Chivers said. "Never had anything to do with cattle. Automobiles is my game. You bet!"

Gus laughed. "In his younger days," he told us, "Sam was one of the best auto mechanics I've ever worked with, even if he always did look like a cow-puncher. Now he runs one of the biggest motor-trucking businesses on the Coast. But don't ask him what kind of loads he's trucking these days—he's working for the U. S. . . . Remember the time we got stalled at that lake up in Nevada, Sam?"

"I sure do," Chivers said. "And I remember how you got us un-stalled. I've heard of women fixing cars with hairpins, but that's the only time I ever saw anyone make one run with a fishline."

"Let's hear it," someone asked.

"Well, Sam and I had been fishing in a lake up in Nevada," Gus said. "After three days we hadn't caught a fish. We hated to get skunked like that, so the last day we stayed out late hoping to get a strike—but we didn't. By the time we got ashore and paid off our Piute Indian guide it was after seven. The railroad station was 35 miles away and we had to make the evening train for San Francisco. Before we had started fishing that morning we had packed our camp stuff in the old Ford we had borrowed for the trip, so all we had to do was hop in. I stepped on the starter. Nothing happened. Dead. We did a quick job of checking, and found the trouble inside of five minutes. The braided battery strap had corroded right through and broken into two pieces, so there was no ground.

"Well, that seemed easy enough to fix—until we started to fix it. We tried to twist the broken ends of the wire braids together, but that wouldn't work. Then we hunted through the tool box, and then through our camping outfit, to find something that we could use as a substitute for the strap. There wasn't anything that would do the job.

"Our Indian guide had put-putted off in his skiff as soon as we had paid him. We decided that we were stuck until someone came along the road—which might be for a couple of days. We were hungry, and Sam began throwing our cooking stuff out of the car. To get at something under our fishing tackle he picked up our reels. You

have to troll deep for the trout in that lake, and almost everyone used a light copper line. Seeing that copper line on the reels gave me an idea.

" 'Hold it, Sam,' I said. I told him what was on my mind and we cut a yard or two of wire off one of the lines. Then Sam helped me lace the copper wire through the two ends of the broken battery strap. That carried the juice all right, and we made town without a stop and in plenty of time for our train."

"Gettin' stalled out in my country ain't much fun for folks who ain't used to there being so much of it," Chivers said. "Sometimes they get pretty panicky when a car stops runnin' maybe 50 miles from the nearest garage. Drivin' around as much as I have to, I often run into dudes—tourists—who are havin' grief, and I always try to help them out. I did that a while ago and got myself up against one of the toughest car mysteries I've ever tackled—and I've gone up against my share of brain-teasers.

"It was over in western Nevada, not so very far from that lake where Gus and I got ourselves layed out. 'Long about sundown one hot day I was drivin' along a dirt road through a wide valley, headin' for U. S. 50. I ain't a scenery hound, but that valley was somethin', and when I came to a place in the road where you can see a lot of miles of it I stopped and got out to have a good look. Any of you gentlemen know that part of Nevada? Well, she's a big country. And she's dry. The mountains on both sides of that valley were mighty high, and there weren't any trees on them—just sagebrush and greasewood that made 'em sort of gray-green and purple.

"I stood there lookin' for quite a spell. Then I happened to glance back over the way I'd come. There was a car comin' along the road, and it sure was actin' locoed. It'd run for a couple of hundred yards, and then stop, and three people would get out and stand around it for maybe five minutes. Then they'd get in and the car'd start—and they'd do the same thing all over again. After a while they got close enough for me to see that the people in the car were women. I figured they were havin' trouble and that it wouldn't be more than decent for me to go back and try to help them. So I did.

"After I'd been drivin' for a couple of minutes I saw the car comin' toward me. It was a '42 sedan of a real good make. All of a sudden it slowed down and pulled off to the side of the road, and the women got out and stood starin' at it. They were sort of elderly. Two of them looked tired and sort of discouraged. The other one was what my old man always called a right upstandin' lady. She was big and husky, and she looked like she'd been used to bein' boss. She'd been cryin', and the tears had made muddy streaks down the dust on her face. But she'd been cryin' with rage—there was static cracklin' out of her eyes.

"I got out and asked them if there was anything I could do to help them.

"The two discouraged-lookin' ladies began talking at once, but they stopped when the big one looked at them. Then she looked me over and said she'd graduated from a Civilian Defense motor-mechanics school and she didn't guess any cow-puncher would know any more about cars than she did.

"So I said easy like that I'd picked up a little about cars, and what seemed to be the matter? That sort of smoothed her down, and she told me that they were from Bawston, and they were touring, and they'd driven up that way to have a look at some real desert country. Their car had been running fine until a couple of hours ago. Then the engine had started missing, and then it had gone dead. They'd fooled with it for a few minutes, and had been able to start it. But it wouldn't run more than a couple of city blocks at a stretch, and they'd been two hours comin' the last five miles. And then the two other ladies managed to get a word in, and say they were scared.

"I told them I reckoned I could find out what was wrong with their car and fix it, and started checking. There was plenty of gas in the tank. The condenser was good. So was the coil. The points were O.K. And the wiring was perfect.

" 'Must be carburetor trouble,' I told them. 'Ten to one your carburetor screen is choked up. That often happens—little bits of rubber slough off gas-pump hoses and work through the tank and fuel line to the carburetor screen.

"I took out the screen, and held it up. And did my face get red! That screen was as clean as a whistle!

"That big woman sort of grunted, and I went back to work without saying anything more. I was pretty certain that the trouble was somewhere in the carburetor—but where? I checked the float, and found it O.K. Then I decided to check the fuel line back from the carburetor toward the tank. I disconnected the copper tube, and something dropped out of it. I picked it

(Continued on page 214)

Mounting, properly done, can make a picture. Here is an example of Konrad Cramer's work on a photograph of himself. Double mounting can be very "dressy," but margins, color, and tone of the intermediate backing require care or the result may be far from pleasing

Mounting Prints for Exhibition

By KONRAD CRAMER

Director, Woodstock School of Photography

MANY excellent photographs, some of salon quality, are taken, processed, printed—and forgotten. The explanation of this curious fact is that amateurs do not always know good photographs, particularly their own, unless they are properly mounted. I have salvaged fine prints from dog-eared piles of supposed "duds," mounted them suitably, and startled their owners.

This is in keeping with a cardinal precept: Never show prints except under the best possible conditions. Mounting is a sure way to set them off to advantage, provided you follow a few simple rules.

Standard mount. The cropped print is fastened directly to the mount. A line may surround the print, but unless it is neat and in proper relation, the effect is bad.

Cut-out mount. Much the same effect as that of the standard mount, but it takes more board, is more difficult, and can look sloppy. Two thicknesses may be used—heavy back, light front—or light stock may be folded (Fig. 2). The knife—and it must be sharp—should be held at a slant for a bevel-cut opening.

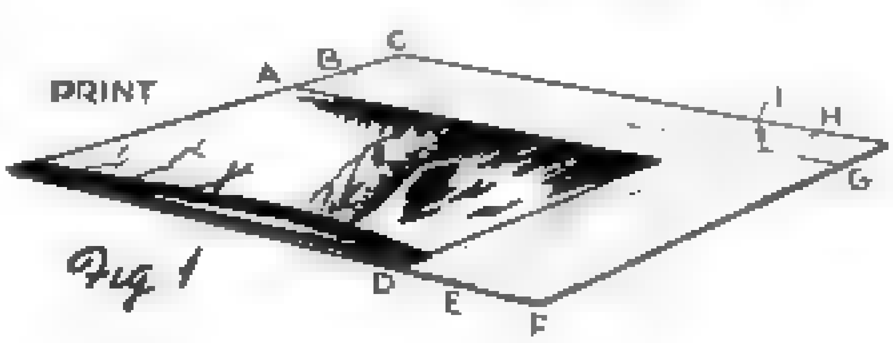
Embossed mount. A very distinguished affair, but a lot of trouble. Cut a beveled piece of hard cardboard (about 1/16" thick) the size of the border to be embossed. Lightly attach it, beveled side to the mount. Put the two in a press, mount uppermost, with a soft, thick felt or blanket on top, and apply pressure (Fig. 3). If the mounting stock shows signs of tearing, moisten the back. A press can be made from parts of a carpenter's vise or an automobile jack. More tedious is to use an embossing tool (Fig 4), pressing the mount against the beveled edge. Take care not to run past the corners.

Double mounting. An intermediate backing between print and mount can be very "dressy," but if margins, color, and tone are not perfect, the effect is far from pleasing. The backing should be about the shade of the print's middle grays; black is also good. Unless the print is mounted under glass, attach it and the backing securely, not just along the top edges.

A black border can be put on the print itself, when it is being made, by covering all except the margin and exposing it. Be sure of the spacing as there can be no cropping.

Simpler is to ink in the border with India ink. Heat the point of a three-pronged lettering pen, and bend the right-hand prong (left if you are left-handed) as in Fig. 5. Lay the print on cardboard with one edge

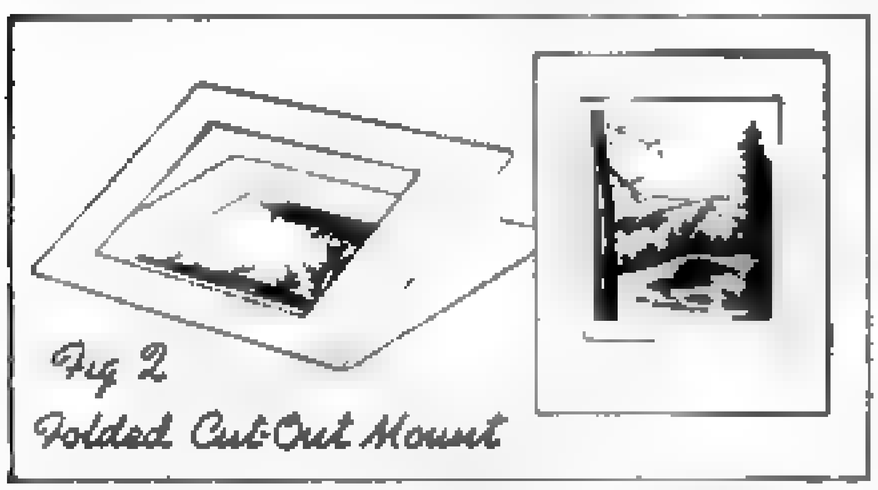
Locating a print on its mount by the geometrical method below works well if the proportions of both are similar. With the print in the corner as shown, mark B on the mount midway of AC, and draw BG parallel to the sides. Mark E midway of DF, and draw EH parallel to the bottom. Then draw DH to obtain the point I. Mount the print with its right edge on BG and its lower right corner at I. At right is the result



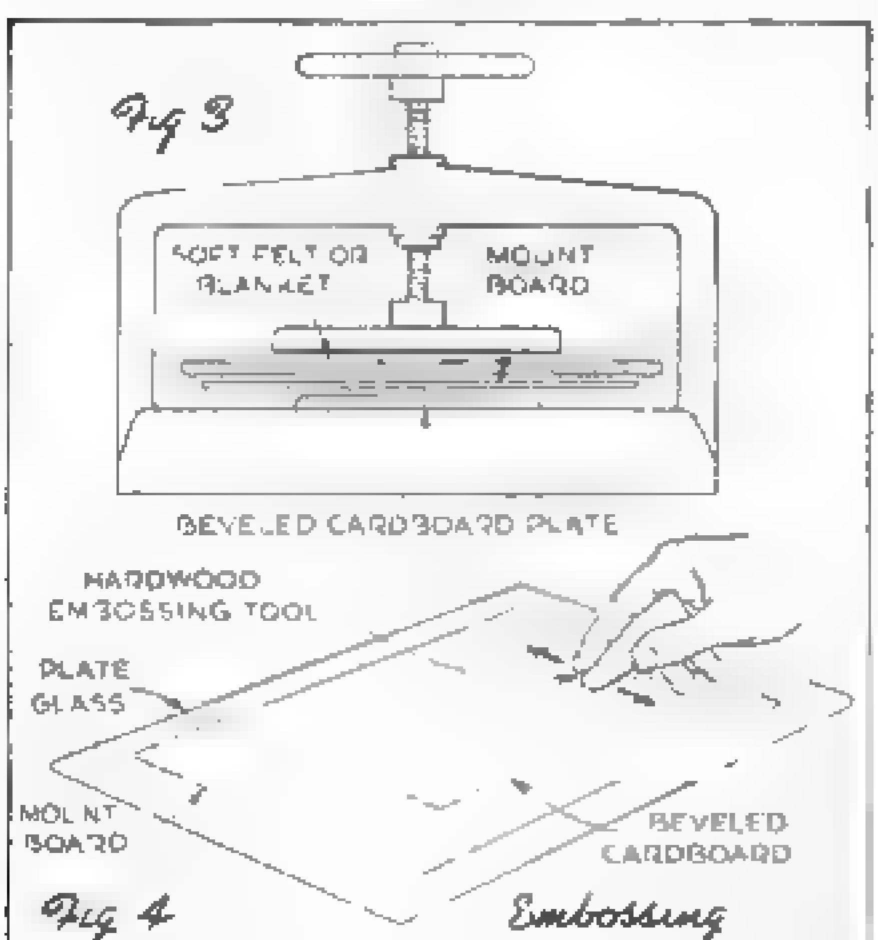
overhanging about ¼". Then with the bent prong against that edge, slowly draw the pen along. Let each edge dry before doing the next. If the paper does not take ink readily, rub with talcum or pumice powder.

Attaching the print to the mount. Glue and paste are messy and may discolor the print. Special photographic paste should be applied as directed on the container. Rubber cement is clean and easy to use, but impermanent. By far the most permanent is the dry mounting tissue impregnated with a composition that melts when heated.

In dry mounting (Fig. 6) place the print face down under an overlapping sheet of tissue, and slide a hot tacking iron lightly from the center toward the edges as at *A*, *B*, *C*, and *D*, attaching the tissue loosely. Trim print and tissue together, and place them, print up, on the mount. Hold flat with the left palm and raise the top right corner of the print with the left thumb and fore finger. Touch the iron to the tissue to stick it to the mount. Without moving the print, repeat for



Cut-out mounts may be made with two thicknesses of stock as well as with one piece folded over



Beveling a margin for an embossed mount is simple if done in a press. Work by hand requires skill

the top left corner, then a third corner. The mount and print are now ready to be permanently bonded.

This may be done with a flatiron. Lay mount and print on clean paper, print up, and cover completely with tough drawing paper and several layers of newspaper or an old ferrotype tin. With the iron medium hot, press from the center toward the margins. Push down hard for about five seconds, then smooth toward the edge, repeating until the entire print is covered. If the iron is too hot, it may scorch the print or stick only mount and tissue; if too cold, it may stick only tissue and print. Bend the mat back slightly, and if the corners pull free, repeat the heating operation.

It may pay to make a press if much mounting is to be done. Around a standard electric hot plate, build a stout, three-sided frame just high enough to hold the press bed close to the heating element. The plates must be clean and smooth, or made so with emery cloth. Heat the contrivance to a degree which practice will determine and turn off the current. Then place your prepared mount, print up, on the bottom plate, put a sheet of clean drawing paper on top, and clamp the pressure plate 20 to 40 seconds. The print should emerge flat and permanently mounted. Cool mounted prints in stacks under a weight.

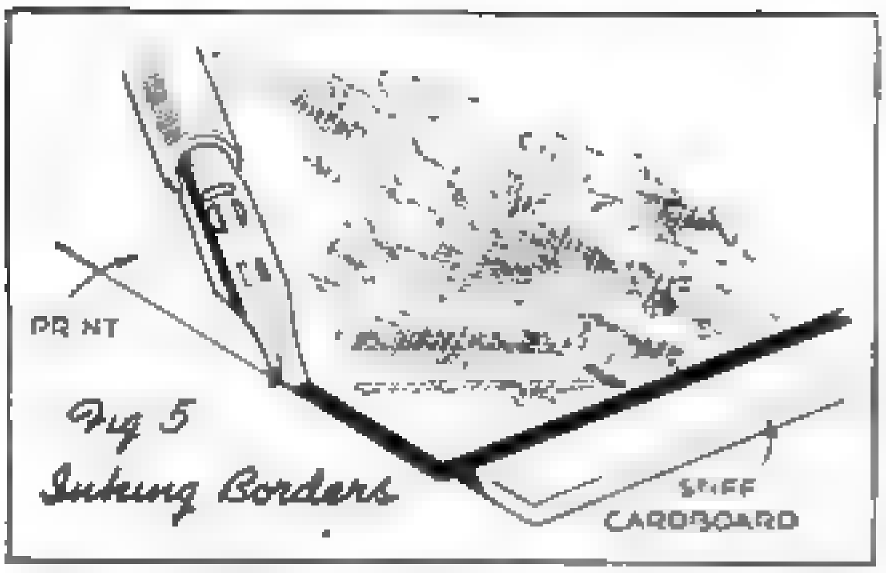
Test frame. At Woodstock we use a slotted 16" by 20" picture frame (Fig. 7) to test mountings. Its ¼" plywood back is held tightly against the glass by pivoted spring clips. A trimmed print is centered on the glass with a mount over it. Sufficient time should be taken to study the result, possibly on the living-room wall

A mounting jig (Fig. 8) is a timesaver. In stiff cardboard the size of your mount, cut an opening a trifle larger than a print, measuring the margins *A*, *B*, *C*, and *D*, carefully. Prepare both horizontal and vertical jigs for prints of different sizes.

Spotting. No matter how meticulously you may work, there will be some small white or black spots on your prints. Light spots are easily filled in with a sharp pencil, crayon, or brush and Chinese ink. Artists' paper stumps are useful for shading. Carbon pencils are preferred by some.

For brush retouching you need a really good sable brush, not too small. The point of a good large brush is as sharp as any. Rub a stick of Chinese ink in a few drops of water on ground glass to make fluid black ink. Dip your brush in clear water and shake off as much as possible, then pick up a bit of the black ink, pulling the brush toward you and rotating it to keep a fine point.

Begin spotting in the middle grays; then,



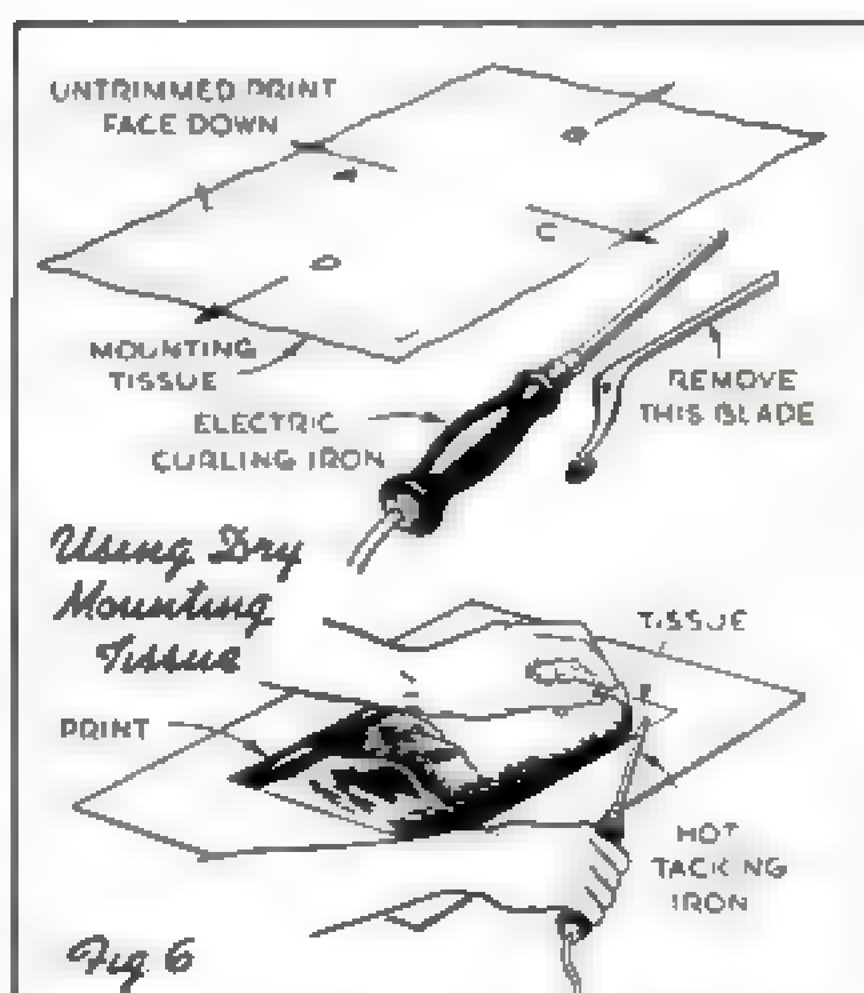
Borders, a variation of double mounting, result in the pleasing effect at right. They may be put on the print with a three-pronged pen, one prong bent down as above

as the ink in your brush gives out, it will match the lighter grays. Rest your brush hand on the little finger and make the brush point dance lightly up and down, leaving very small spots. Figure 9 shows a group of these spots greatly enlarged. Don't try to stay in a blemish's bounds, as at *A*, but blend your dots with the surrounding area *(B)* to avoid outlining the place.

If your brush leaves a spot shaped as at *C*, rotate the point over a clean blotter to free it of excess moisture. The brush works best when almost dry. To cover spots in the darkest areas, you may have to take more ink. For fine work and on glossy prints, use saliva instead of water. The professional spotter's left thumbnail is his ink pallet. Beginners incline to too much water, too much paint, and not enough patience. With practice, you may even remove those long white scratches common in beginners' prints from small film. Should a light spot be filled in too dark, moisten your finger, wipe the ink off, and try again.

Black spots are more difficult. With a very light touch, scrape a small etching knife or a piece of razor blade in a handle (Fig. 10) across the spot in several directions until it disappears. The knife must be sharp or it will dig into the paper. Viewed across the light, the spot will still appear dark because of the roughened surface, but this cannot be helped. Burnishing with a fingernail will minimize it.

Titles. Pages might be devoted to this; a few suggestions may help. The title should not be written or printed in bold letters on the front of the mount, and never in the lower left corner of the print itself. If it



Dry mounting tissue is by far the best adhesive for permanent work. A common electric curling iron with the cold blade removed does nicely as a tacking iron. The tissue is tacked first to the print, next to the mount, and then attached firmly

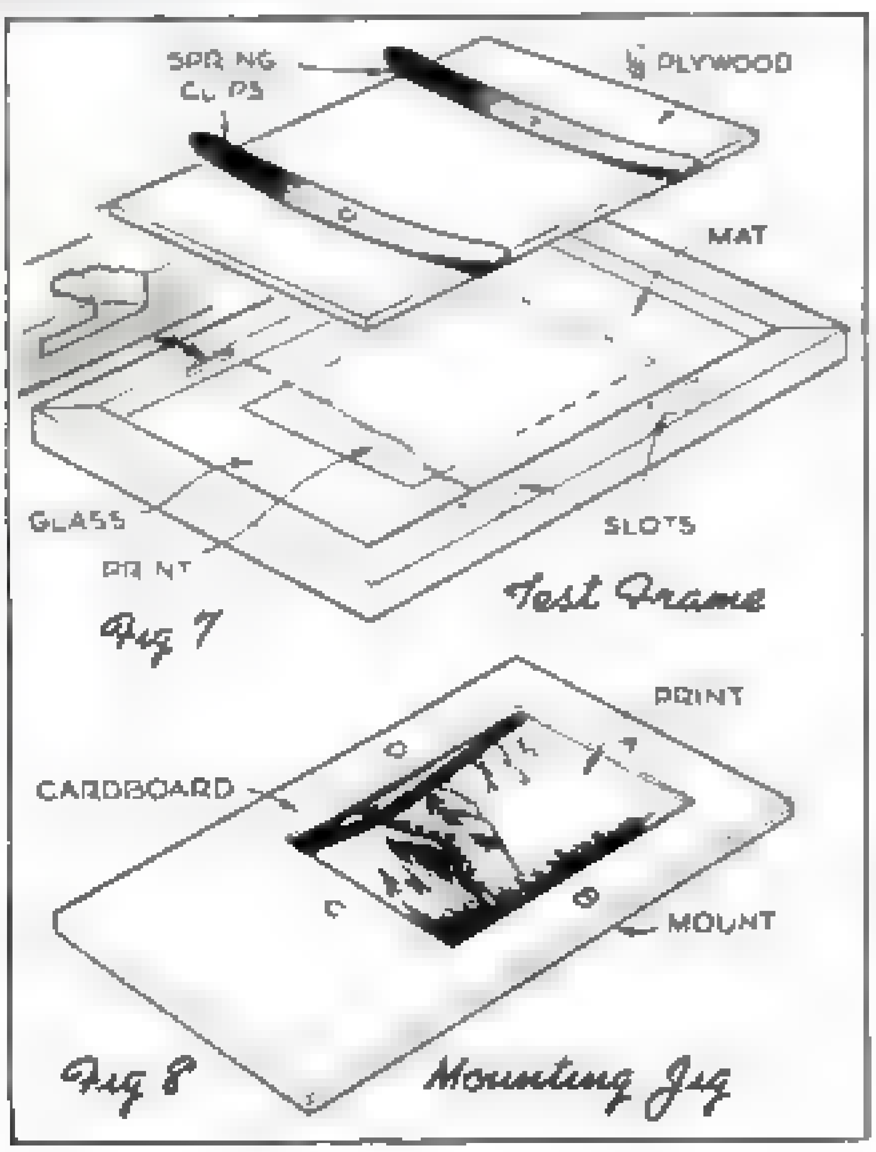
THINGS NOT TO DO. This freak mounting spoils a good picture. Badly proportioned margins, trite title, and bold, poorly placed signature detract from the subject

must be on the front, place it along the lower left margin of the mount in small, neat lettering or on a small attached card. The best place is at the top left corner of the back of the mount. Include technical data; it is interesting.

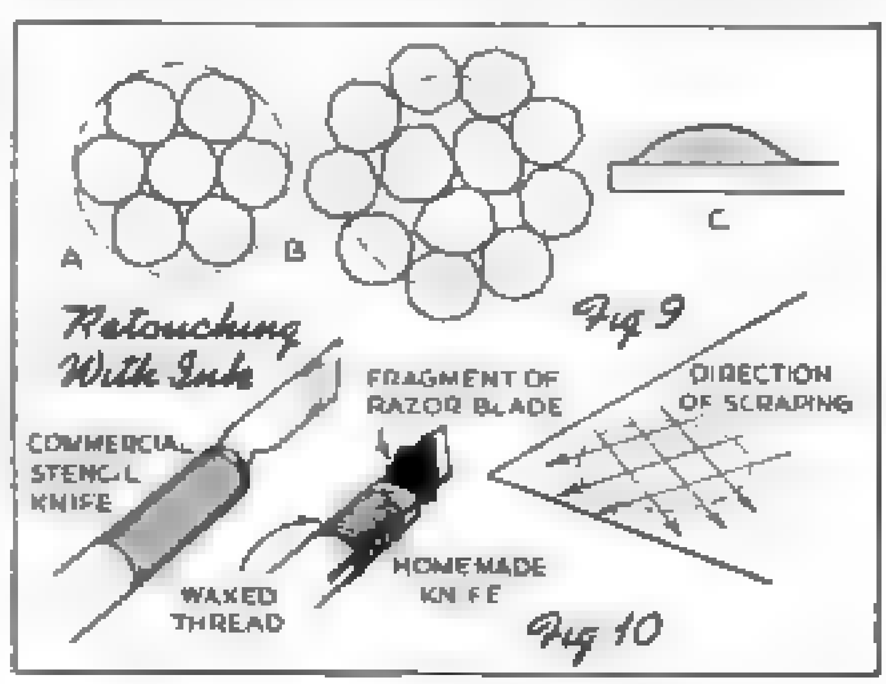
Show restraint and taste in choosing titles. Don't try to tell a story that is not in the picture, nor, on the other hand, underscore the obvious.

Signatures. Your best prints should be signed as a seal to the personal and pictorial statement made by the print. The purpose of your signature is to identify the creator, so add the city in which you live—somebody may want to buy the print or order a picture.

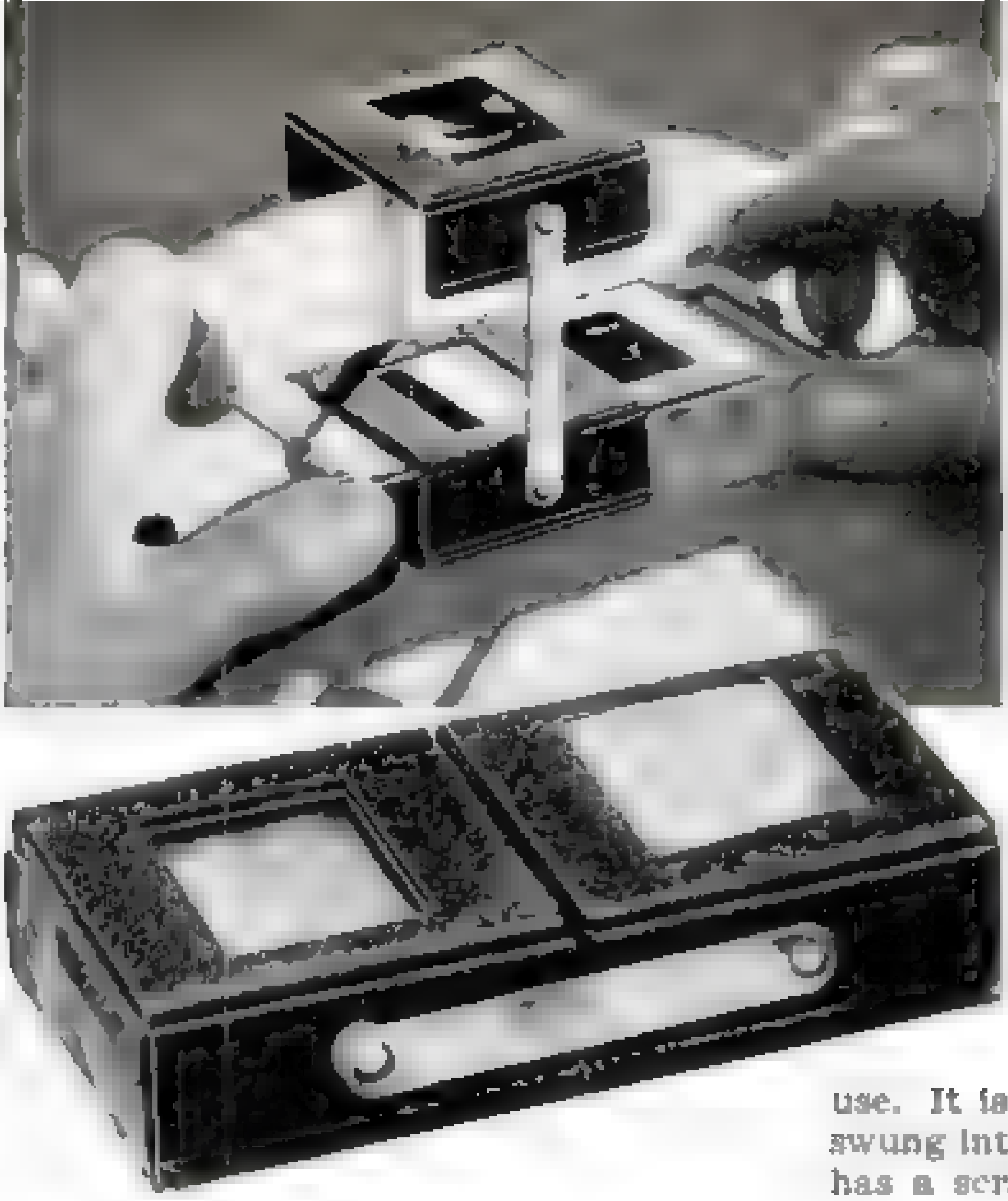
The style is personal—handwritten or printed—but it should be simple and unobtrusive. Bold signatures defeat their purpose. To design a signature to suit print and mount, letter it in various ways on 1" by 3" pieces of paper similar to the mount stock, and try them in different positions. Do not use a soft pencil or ordinary ink. A sharp, hard pencil is ideal, or use India ink.



In touching out blemishes, brush spots (enlarged below) should blend into outside areas. Spot C shows too much water. Figure 10, scraping knives



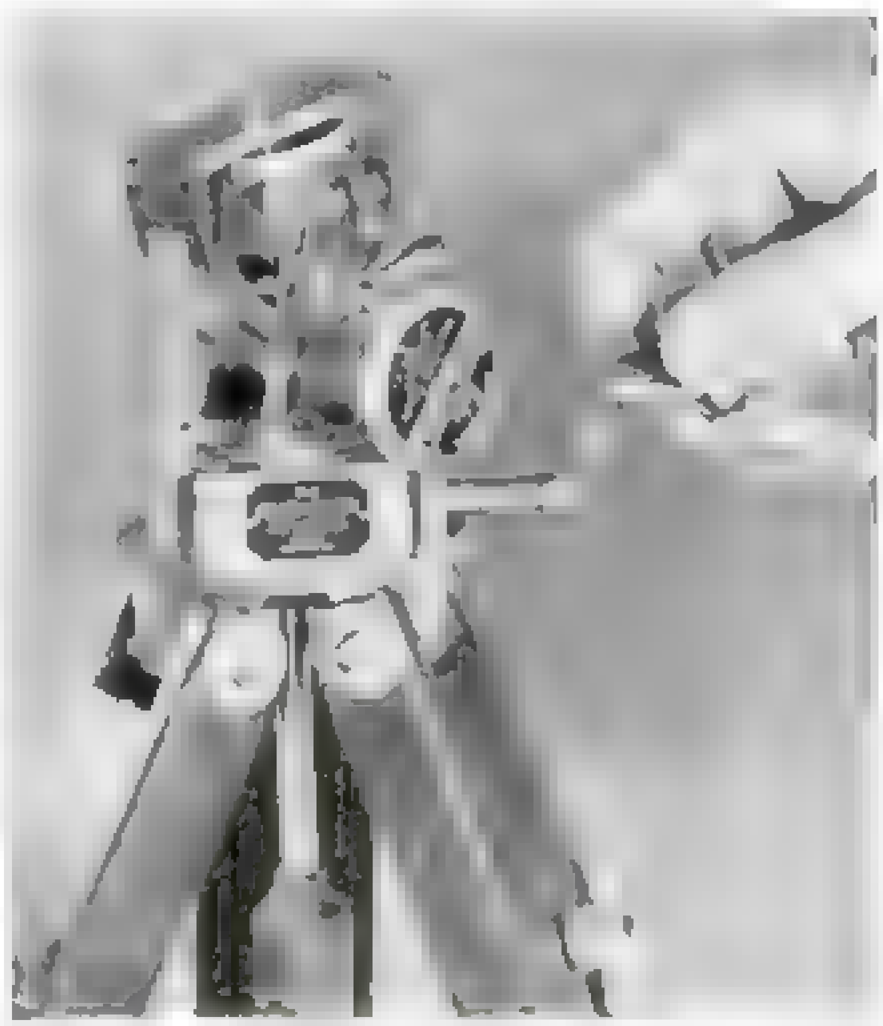
FOR CAMERA USERS

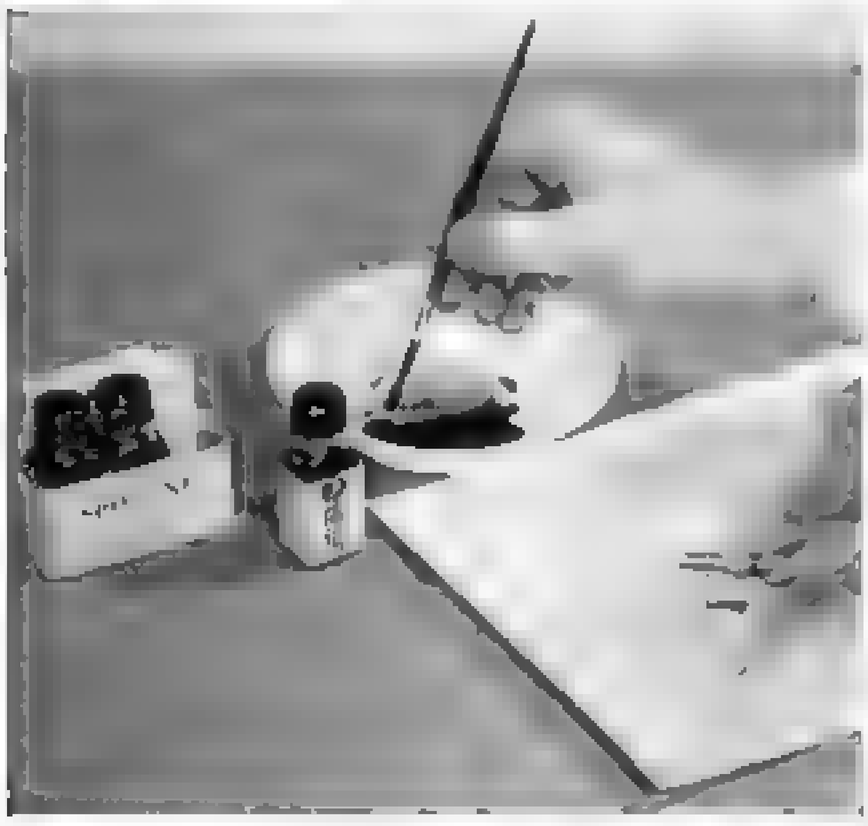


SLIDE VIEWER AND CARRIER

Protection for miniature color slides in transit is provided by this battery-lighted viewer and magnifier equipped with a magazine-type carrying case. Its simplified operation includes automatic ejection of the slide just viewed into the magazine when a new slide is inserted in the viewing frame. The magnifier, enlarging to three diameters, fits flat on the case when not in use. It is mounted so that it can be instantly swung into position for viewing slides. The unit has a scratch-resistant crinkle finish.

TILTING AND PANNING are accomplished by a positive and accurate geared action in this all-gear tripod head designed for use with many types of both movie and still cameras. Among its features are a built-in bubble vial for true horizons and level panning, and a locking lever. The head can be turned completely around and tilted up or down in a 180-deg. arc by a handle so arranged that it will not interfere with the line of vision. The unit will fit tripod bases up to 3½". A specially selected lubricant is packed in to eliminate the need for oiling.



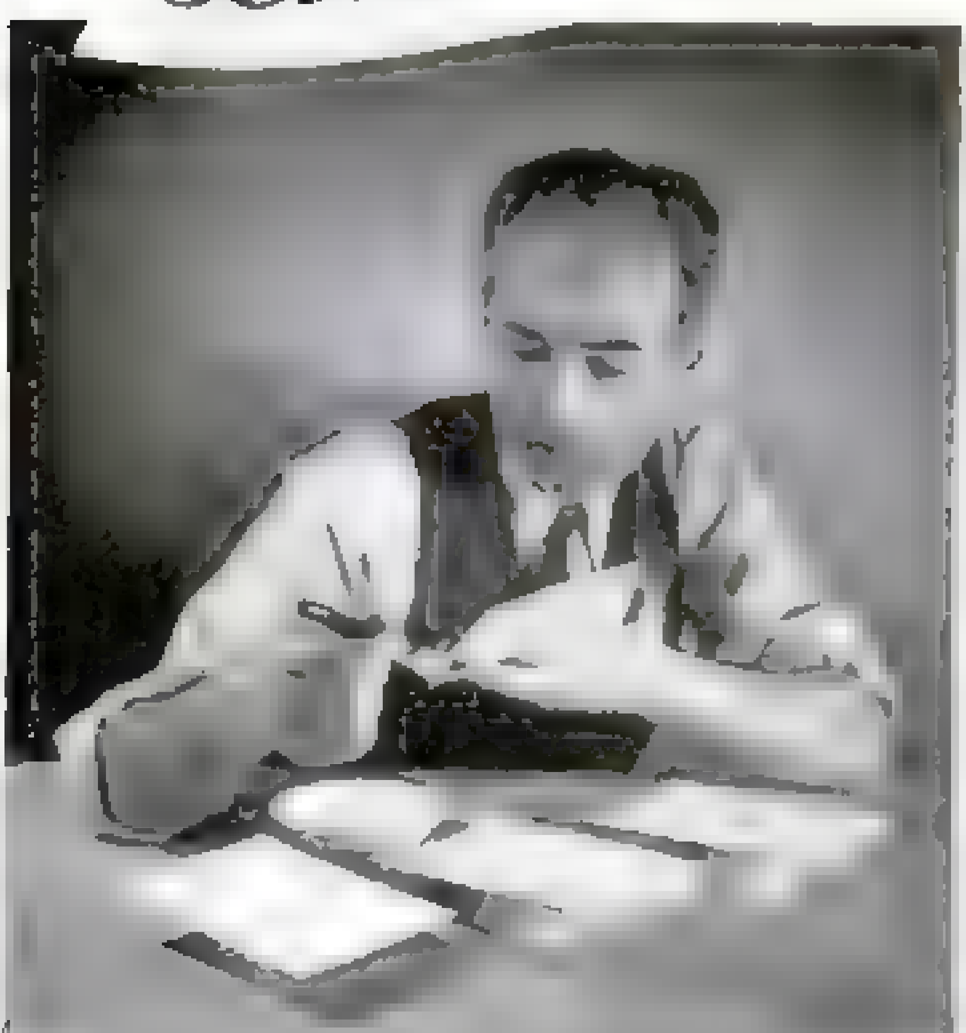


Retouching can be made to blend readily on prints or negatives with stain dyes, used alone or mixed

THREE NEW RETOUCHING DYES—blue-black, sepia, and neutral—are now available for use on negatives or glossy and mat prints. Any dye in the set may be mixed with either or both of the others to produce a wide variety of retouching colors. All three have been developed on the stain principle, and will penetrate any print emulsion without leaving a residue, or build smooth, grainless tones on negatives, working either on the emulsion side or on the back.

White titles stand out brilliantly on a dark or black background. They can be lettered for home movies with an ice-pick stylus on artists' scratchboard or on an easily prepared substitute

SCRATCHBOARD MOVIE TITLES



To make up improvised scratchboard, first paint heavy cardboard with two or more coats of ordinary white ink

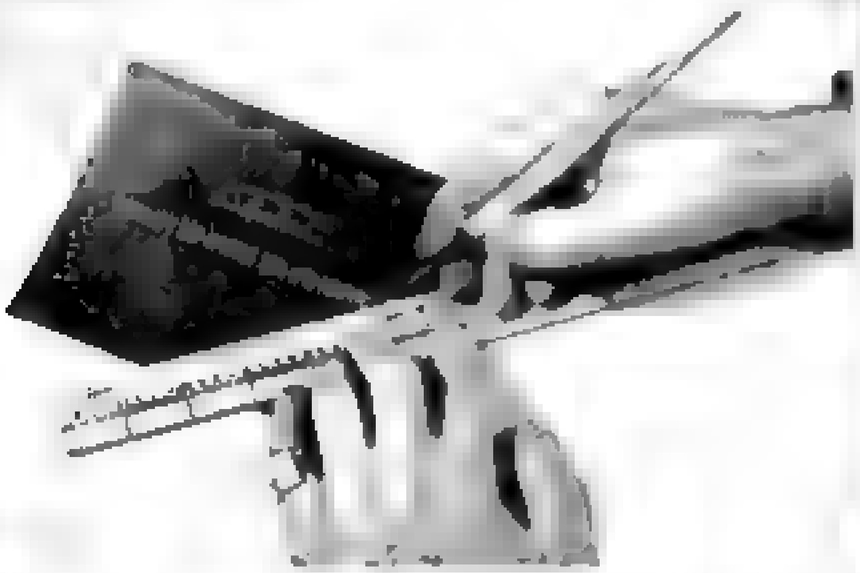
By KENNETH MURRAY

SHARP, vivid home-movie titles can be made without trouble on artists' scratchboard. This is a pure-white, clay-coated cardboard that can be obtained where artists' supplies are sold. To use it for movie titles, merely coat the surface with black drawing or India ink, then letter the title in with a sharp point instead of pen or brush. The white lines stand out brilliantly distinct against the black background. The method overcomes the usual difficulty in doing good lettering with white ink on black cardboard.

A suitable tool or stylus can be fashioned by breaking the steel point from an ice pick and sharpening it. Use it in an ordinary wooden penholder in the end of which a hole has been drilled to an easy fit. The point scratches the clay coating on the drawing board, removing black ink to form sharp white lines. If an error is made, merely coat that portion with black ink again and scratch the lines

When the white ink is dry, cover it with black drawing ink. A pipe cleaner serves as a brush

For a stylus, fit the end of an ice pick into a hole in a penholder. Reverse it when not in use



Outline letters carefully to get the proper spacing. A pencil may be used if preferred

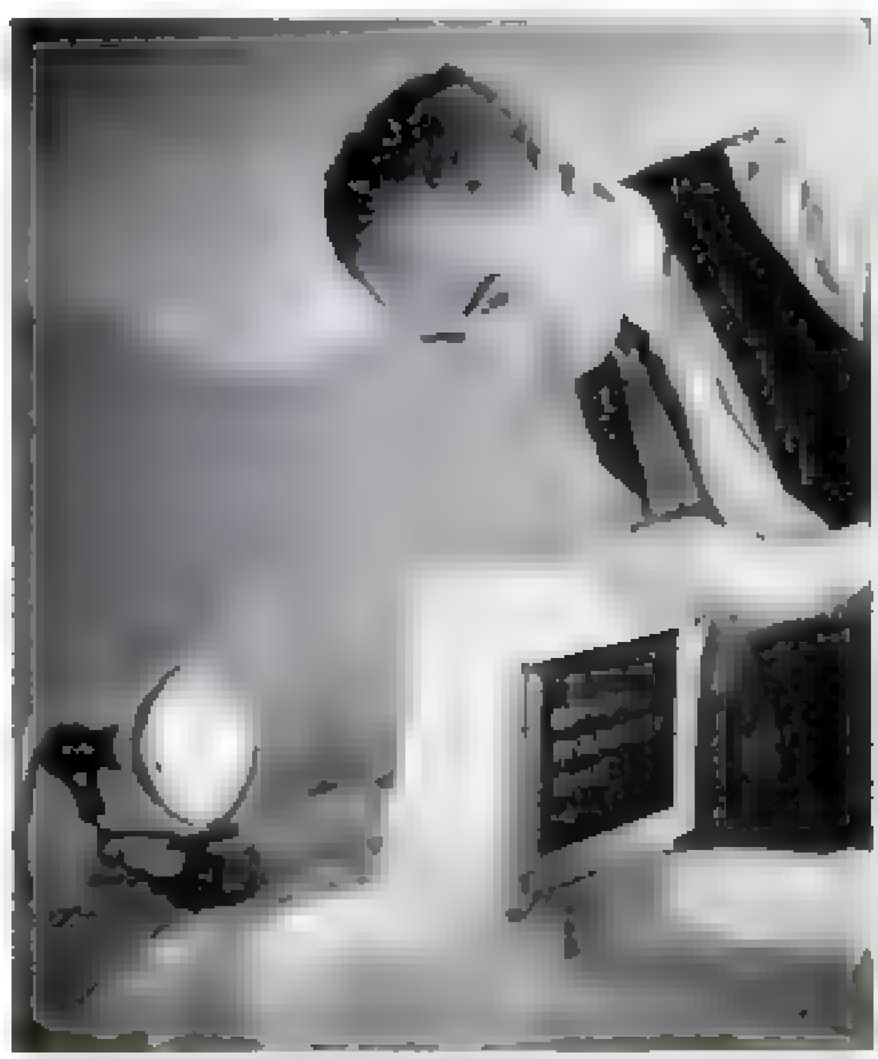
Hold the stylus almost flat to remove black ink from the letters and reveal the white undercoat

over. Make sure that the ink is dry before starting work or correcting errors. Lettering may be outlined first with an ordinary pencil to assure accurate spacing. Double lines can be scratched in with a divider.

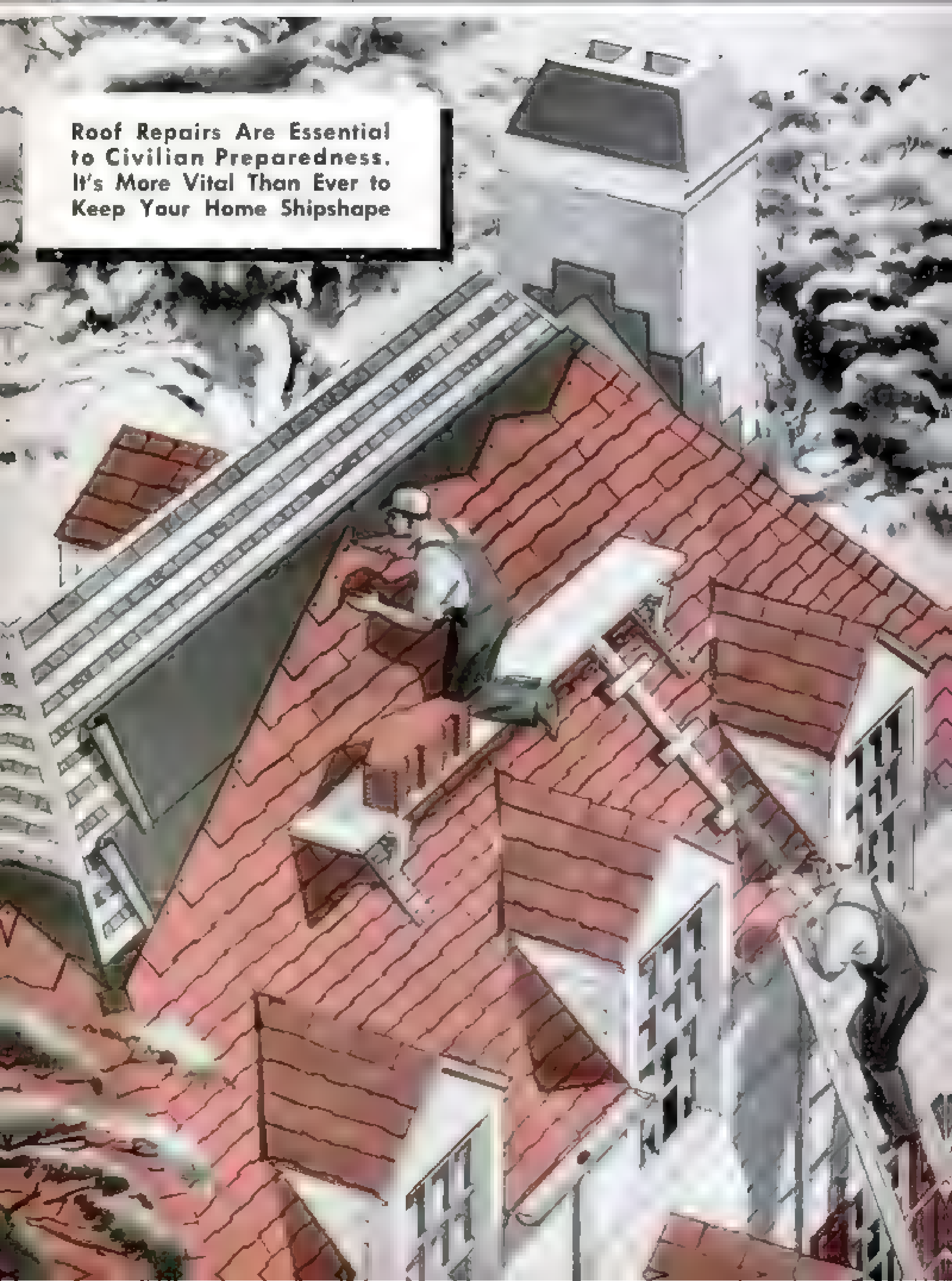
For a different background effect, a gray coating can be made by diluting liquid shellac with an equal part of denatured alcohol and mixing in lampblack until it becomes the desired shade. To give the background a textured effect, cover the scratchboard with a sheet of fine, medium, or coarse sandpaper, face down, and tap gently with a wooden mallet.

Should regular artists' scratchboard be hard to obtain, good results can be had by painting heavy cardboard with two or more coats of ordinary white ink. The finish must be heavy enough to hold up under the scratching of the stylus.

An interesting variation consists in covering a sheet of glass with black ink. The lettering will then be transparent and can be photographed with any suitable light behind the glass, or a small concentrating spotlight can be used to illuminate one word at a time.



Titles lettered on inked glass and illuminated from behind will provide many interesting effects



Roof Repairs Are Essential to Civilian Preparedness. It's More Vital Than Ever to Keep Your Home Shipshape

Keeping a Roof Over Your Head

IMPROVE YOUR HOME NOW

By CARL T. SIGMAN
and WILLIAM J. WARD, JR.

IT'S PATRIOTIC to be careful of our automobiles because no more cars can be built for the duration. But no more houses, except those necessary in defense areas, are being built either. It's even more important to keep our houses "in sound working condition," as a government order puts it, than to keep our tires inflated; many of us can get along without cars, but none can do without a roof.

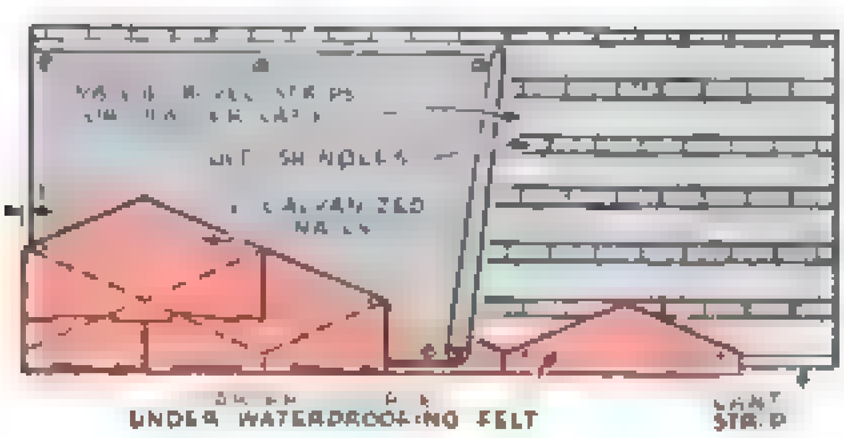
To get down to cases, how many mornings have you awakened to be greeted with that nasty stain on your bedroom ceiling? It looks at you and says, "Fix that roof, or I'll get worse and maybe shower down a little plaster in your eye!"

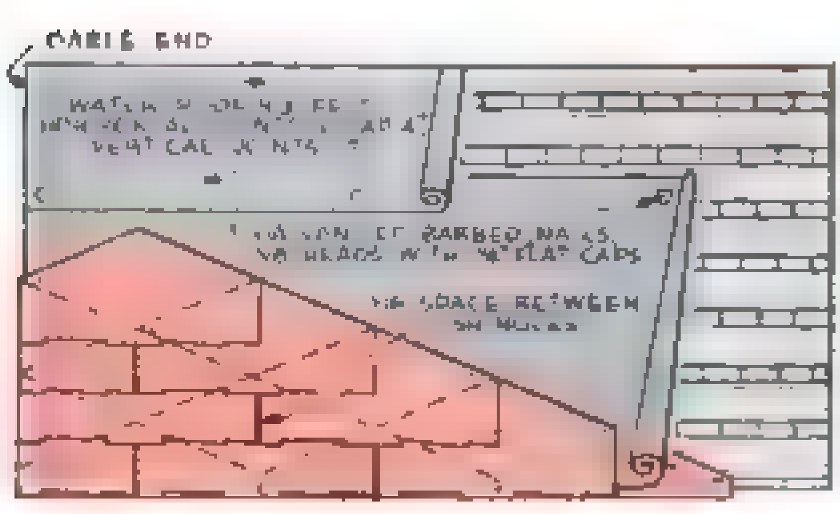
It would be simple, perhaps, to locate the leak if the stain was directly under the defective shingles, but it usually isn't. Water has a way of running down rafters and along valleys for considerable distances before soaking through plaster and paper.

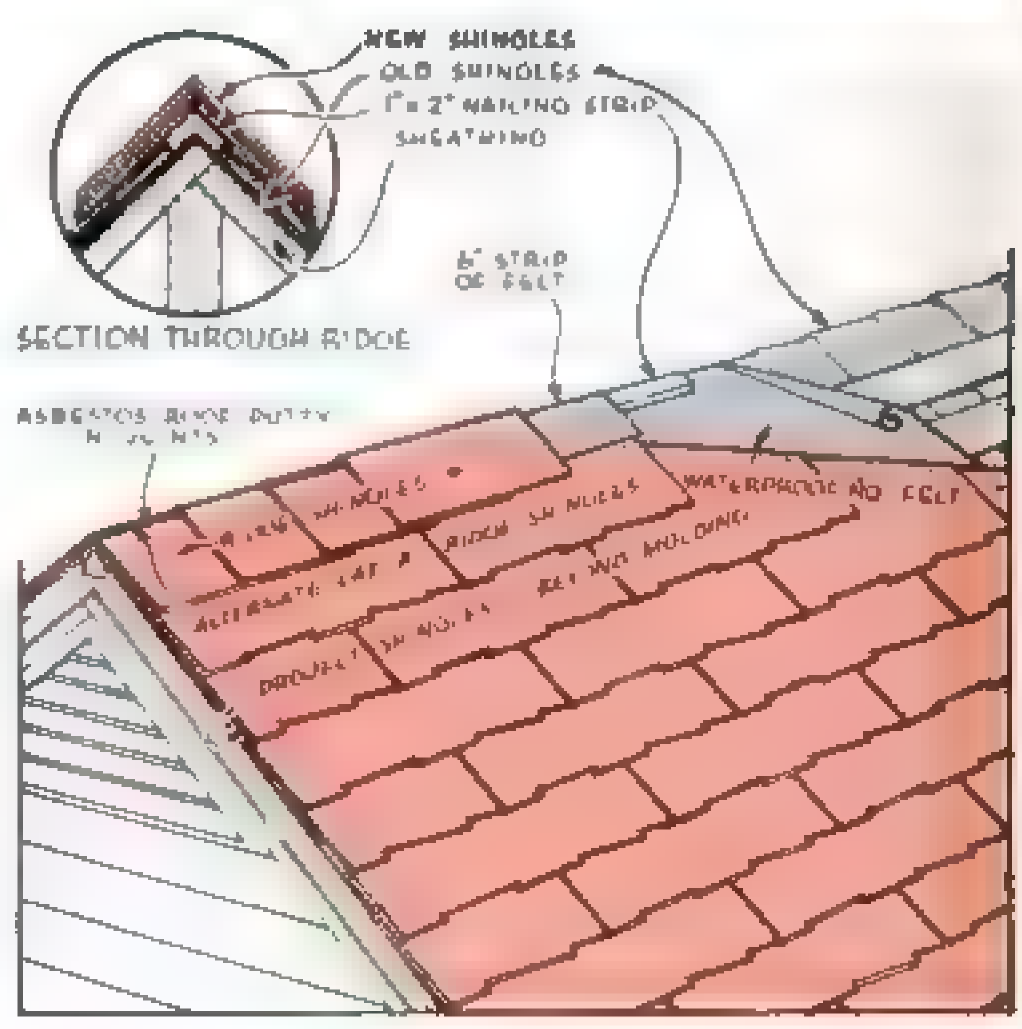
You can locate the trouble best during a rain, but when that's not possible, the telltale stains can often be followed by a little detective work to the source. Then, if your house has open-slat sheathing, you can pass short lengths of wire or wire nails through the openings to project to the roof above as shown in the illustration at the top of the following page. However, with closed sheathing or an inaccessible attic, that may not be possible, and only the approximate location can be determined.

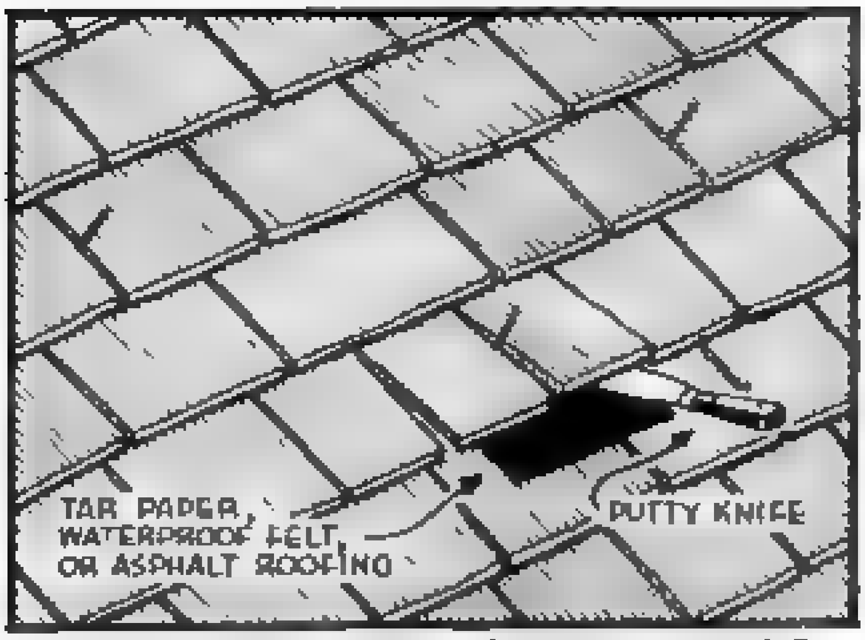
Then to the roof you must go—which at best is dangerous both to the repairman and the roof. First fix yourself a roof ladder, which may be simply a 12" wide board with slats for steps nailed to it. This is hooked to,

QUICKLY APPLIED ASBESTOS-CEMENT SHINGLES

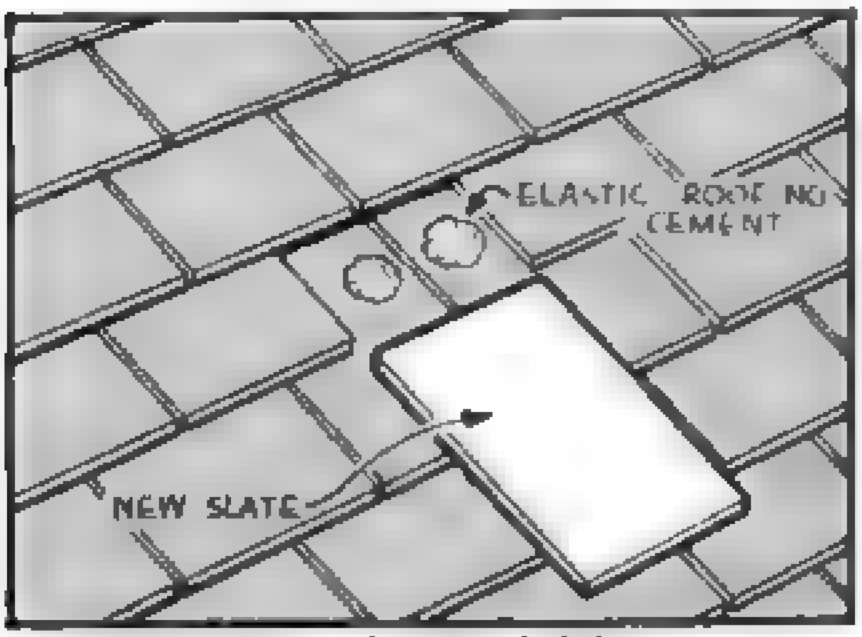




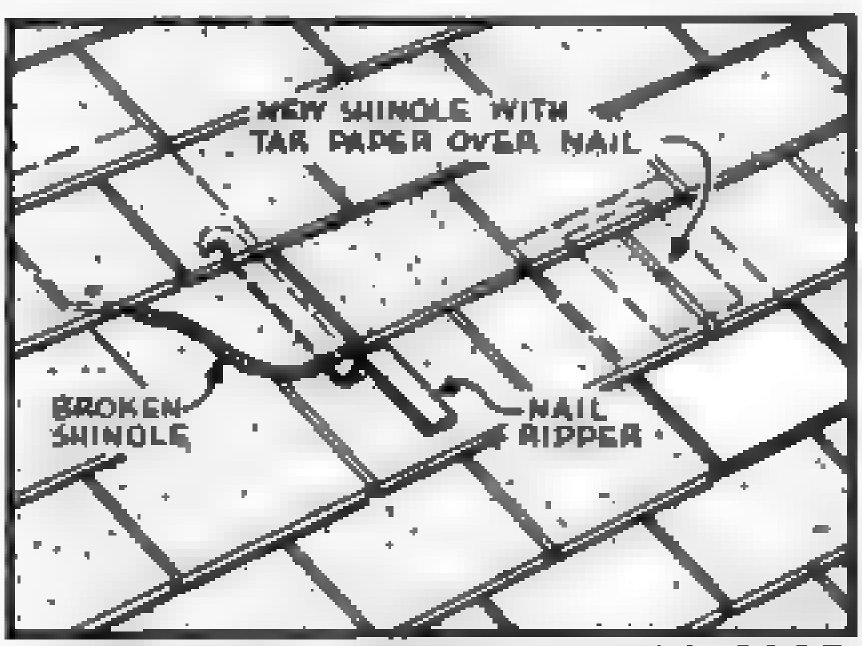




1. REPAIRING WOOD-SHINGLE ROOF



2. REPAIRING SLATE ROOF



3. REPAIRING ASBESTOS-CEMENT ROOF


4. REPAIRING ASPHALT STRIP SHINGLES

or hung from, the ridge. If you have a light ladder, you can make a satisfactory arrangement for fastening it at the ridge by using 1" by 3" or 1" by 4" stock as shown in a drawing on the last page of this article. Or perhaps you can obtain a roof hook.

So, armed with a putty knife, a number of 3" by 5" or 3" by 6" pieces of single-ply waterproof felt or tar paper and some roofing cement, you proceed to mend the leaks. With the putty knife, as shown in the upper drawing on this page, raise the end of the defective shingle and push the tar paper under as far as possible. If necessary, use a bit of roofing cement to hold the patch.

When old shingles are badly split or rotted, they should be replaced with new ones. Split up the old shingles with a hatchet and draw out or hammer down all nails before laying the new shingles. Make sure that no joint between shingles comes over another.

Some surface nailing is inevitable in replacement work. For this use hot-dipped zinc-coated nails, 1¾" or 2" long. Nails of this type really should be used for unexposed or hidden nailing as well. One caution in nailing a wood shingle is to avoid hitting the nail again after it is flush with the wood. To do so crushes the shingle and increases the danger of rot.

New shingles on an old roof are more conspicuous than the proverbial sore thumb, so dip them in a preservative to which color has been added to match, as nearly as possible, the old roof. Commercial stains are not always completely satisfactory as preservatives. You can make a preservative yourself in the proportion of a gallon of coal-tar creosote oil, two gallons of raw linseed oil, and a half gallon of japan drier. This will give a warm brown color. If another color is desired, add a gallon of a composition consisting of a color ground in oil and mixed with linseed oil to the consistency of paint.

If you have a slate roof, you need worry only about an occasional slate cracking or falling out. Use a nail ripper as shown in drawing No. 3 on this page to release the old slate, or use a thin hack-saw blade to cut the nails. To make a ripper, file a notch near the end of the back of a saw. Butter the new slate with roofing cement and force it in place. In climbing on a slate or other roof, wear rubber-soled shoes to avoid damaging the shingles.

Asbestos-cement shingles rot or split no oftener than slate and need only occasional replacement. As previously described, re-

Frequently leaks can be mended with the replacement of a few shingles—wood, slate, or composition—or one or more strips. Locate the leak from below and mark it to speed up your job on the roof

move nails with a ripper and slip in the new shingle. To hold it in place, drive a single 1¾" galvanized roofing nail through a hole punched in the center of the shingle. Cover the nailhead with a small piece of tar or asphalt roofing paper to prevent water from running into the nail hole. Rust stains asbestos-cement shingles badly.

If a strip of asphalt shingles needs replacing, a new section can be cemented over the old section. Only one nail is needed.

But, as to an old inner tube, there comes a time when patching is no longer possible. In such cases consider the matter of applying a new roof over the old one. Besides improving the house, it will provide additional insulation. Of the many materials available, the three most widely used are asbestos cement, which consists of asbestos fibers and Portland cement made under great hydraulic pressure; mineral-coated, felt-based asphalt; and wood, of which redwood, cypress, and cedar are the main ones split for shingles.

Before applying the new roof, several steps should be taken to prepare the old shingles. First, as you will see at the right, the old, curled shingles must be split with a hatchet and the corners nailed down. If any are too badly rotted, they should be replaced, though since rotting takes place only in the presence of moisture, the new covering will probably halt it.

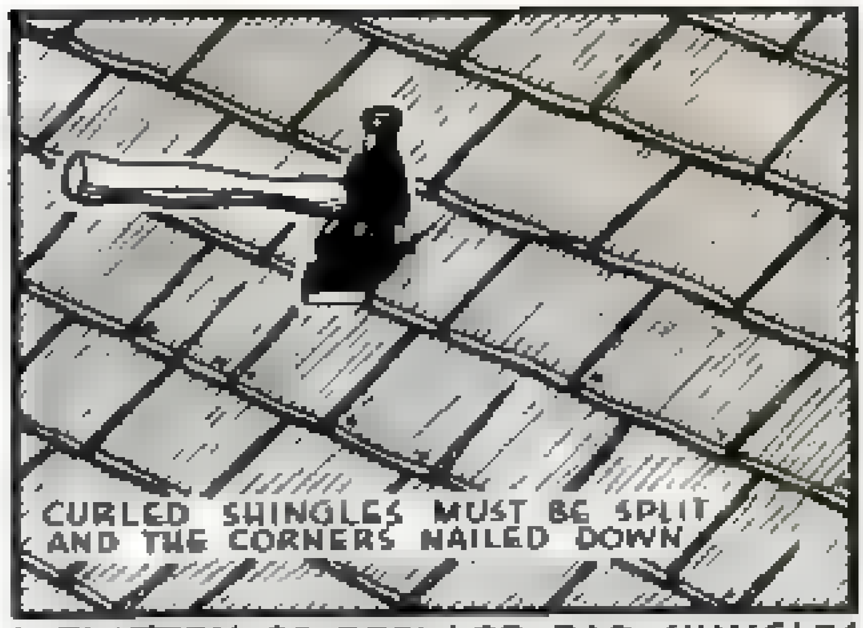
Next, if a composition shingle is to be used, where the weather exposure does not coincide with that of the old roof, the roof should be leveled by nailing in place ⅜" by 4" bevel strips or common plaster lath as shown in drawing No. 2 at right.

Then, along the gable end of the roof, cut out all shingles with a hatchet down to the old sheathing and replace with a 1" by 2" or 1" by 3" board. Repeat this process along the eaves. This will give the new shingles a more secure nailing surface around the edges of the roof and improve the appearance, but is not absolutely essential.

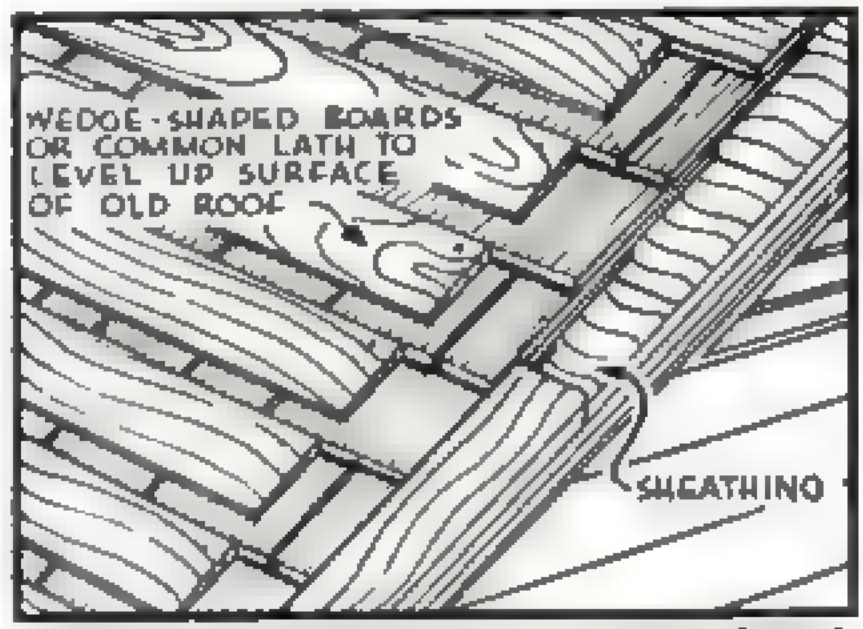
Next, the old valley should be partially filled with wood strips to the level of the old shingles. Over this, new flashing must be applied. This consists of two layers of heavy-weight, smooth or slate-surfaced roofing or mineral roll roofing, since metal for flashing is out for the duration.

The lower valley strip, as shown in drawing No. 4 on this page, should be 12" wide and the top one 24"—both strips preferably in one piece running the entire length of

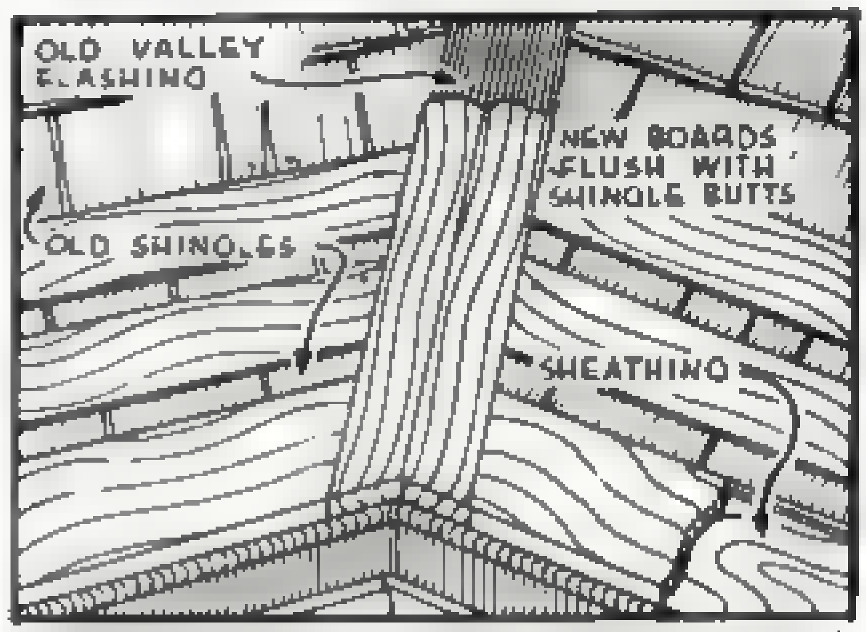
When a roof is too far gone to be saved with patching, a reroofing job becomes necessary. Four steps in preparing an old roof to take the new covering are illustrated in the drawings at the right



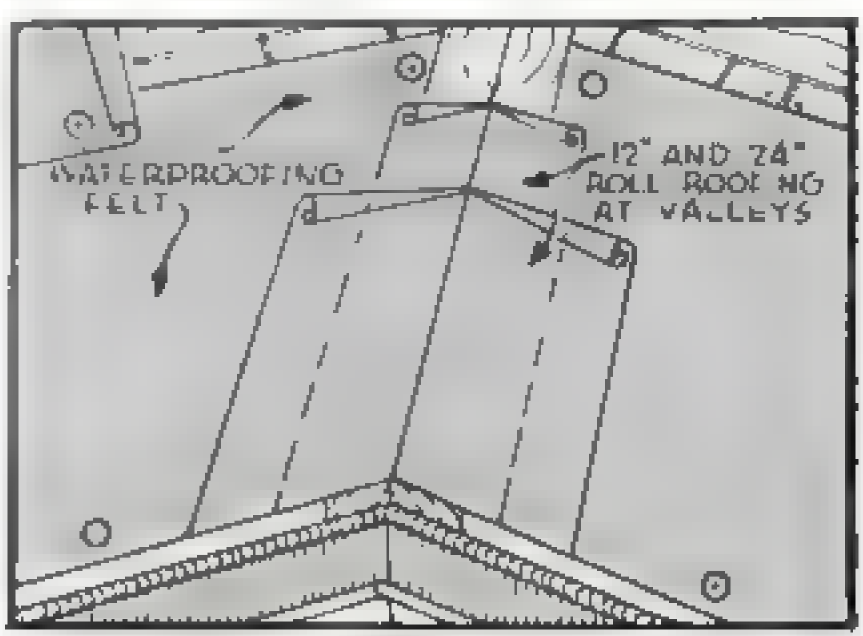
1 FLATTEN OR REPLACE BAD SHINGLES



2 REPLACE SHINGLES AT GABLE WITH BOARD



3. NEW BOARDS AT CORNICES AND VALLEYS



4. LAY FELT ON ROOF AND FLASH VALLEYS

Most asphalt shingles are of the strip type with two to four shingles to the strip. They are made in a variety of colors, either monotones or harmonizing shades, and are fire resistant, but not fireproof

the valley. Nail on 12" centers ¾" from the outside edges, using large-head 1¾" galvanized roofing nails. If joints are necessary, they must lap at least 9". Shingles should be applied, exposing 4" of the flashing on either side of the valley at the top and 5" at the lower end.

For a tighter job, you can cover the roof next with waterproof felt or paper lapped at least 2" at each joint. At the ridges and hips 1" by 2" nailing strips should be secured and covered with an 8" or 10" wide strip of waterproof felt or paper.

Roofers vary as to the extent of preparation. Of the four suggestions illustrated on page HW 195, only on the first do all agree. The others are advisable but not essential.

Perhaps you will discover that the metal gutters and leaders are worse than you thought. With metal scarce, consider the new redwood gutters and leaders illustrated on page HW 198. They will last many years.

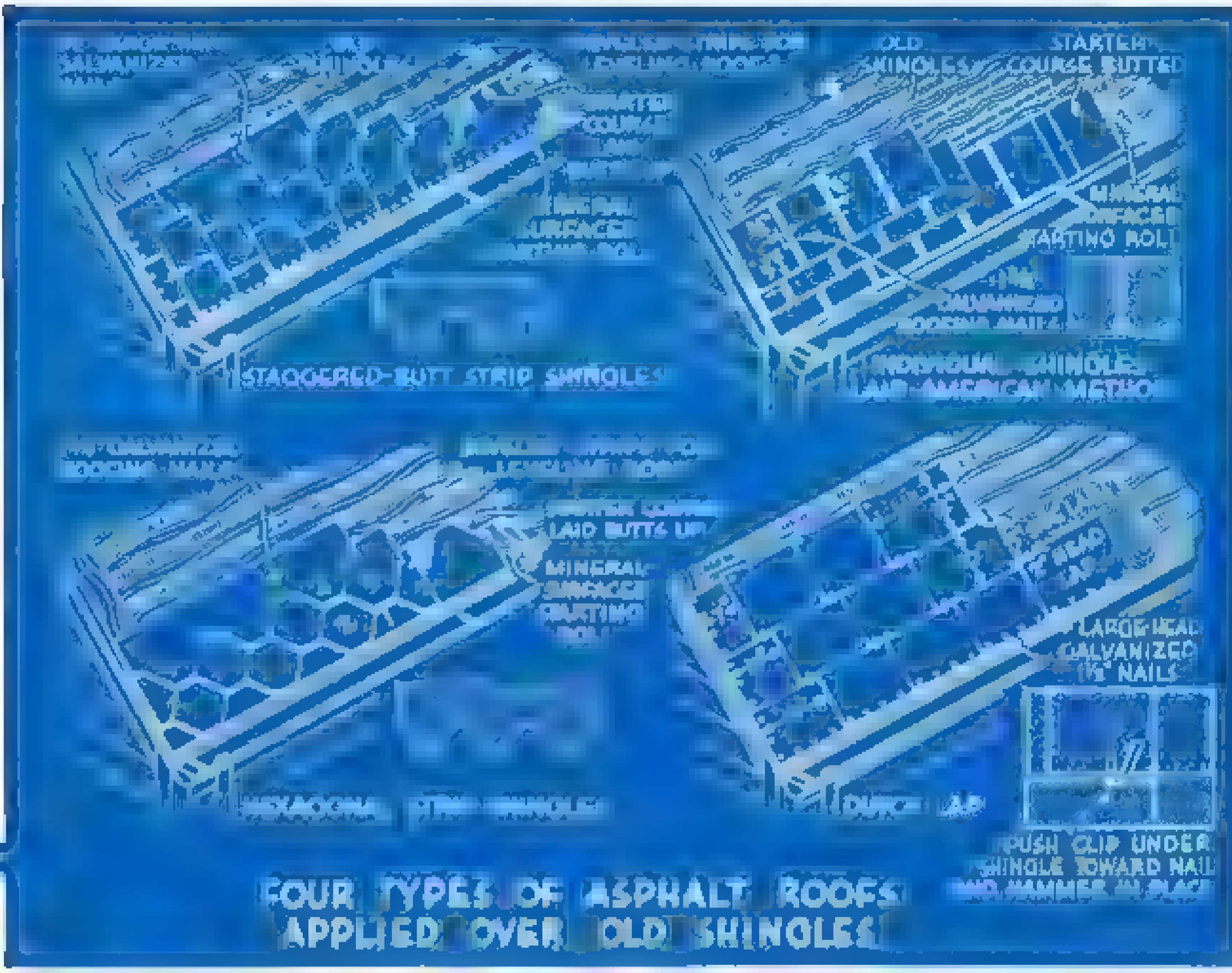
On page HW 193 is shown the method of applying one of a number of types of asbestos-cement shingles. The variety illustrated is one of the lower priced, and is designed to be laid rapidly. Like all other asbestos shingles, it comes in a variety of colors and either smooth or with a texture to resemble the graining of cypress or cedar.

All shingles are sold by the "square," which means the number needed to cover 100 square feet of roof, except so-called "eave-starter" shingles and hip-and-ridge shingles, which are sold separately and in special sizes.

All asbestos shingles come drilled with nail holes so that there can be no mistake. Manufacturers supply 1¾" or 2" galvanized roofing nails with the shingles.

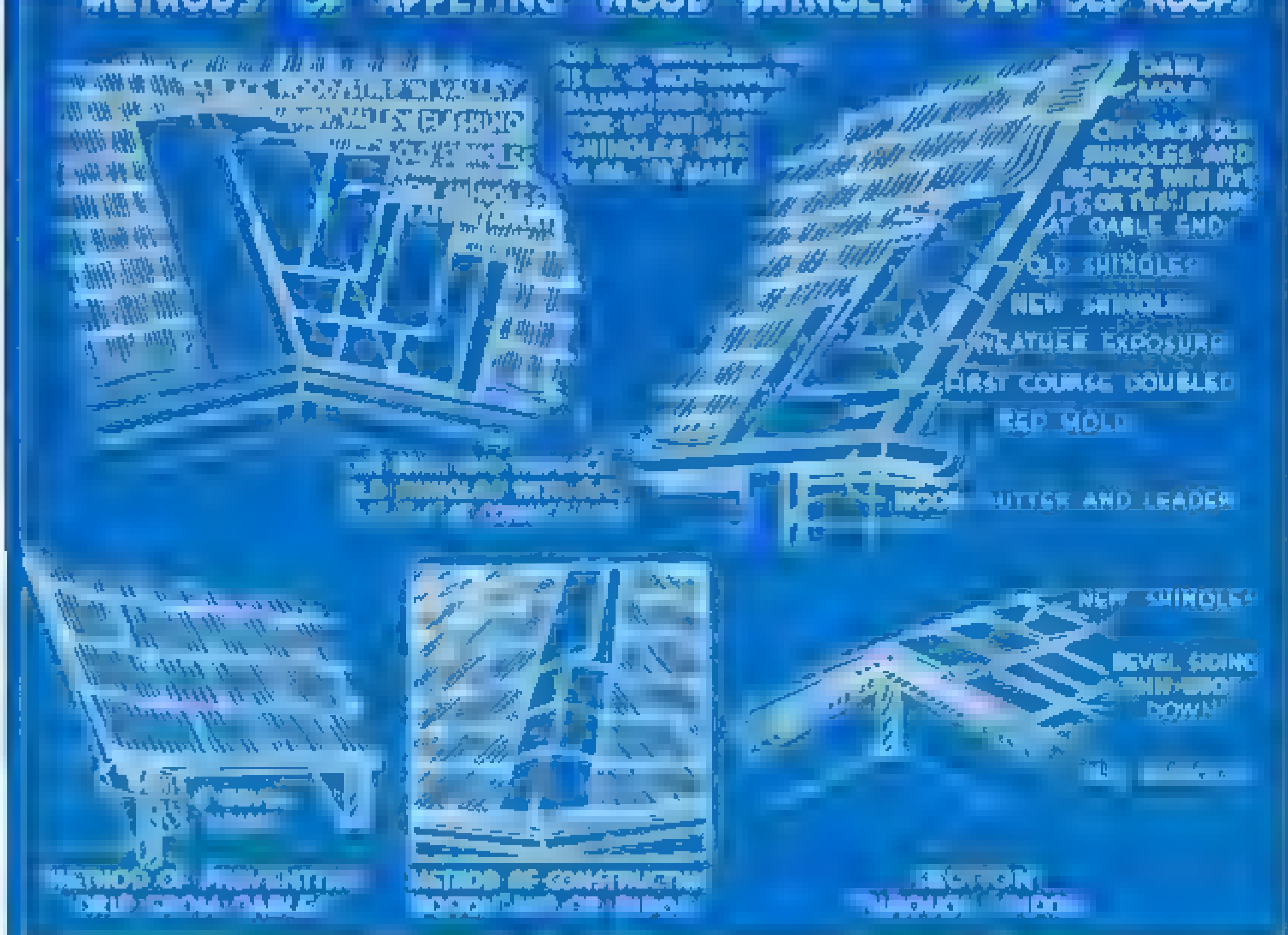
With asphalt shingles, a still greater variety of colors is available, both single colors and harmonizing colors for a single roof. They are fire resistant, and most types carry the Underwriters' laboratory class "C" rating as compared with the class "B" rating of asbestos shingles. They cost less than asbestos and, as a rule, are generally less expensive to install. Most are of the strip type—that is two to four shingles per strip such as in the bird's-eye perspective at the top of this page.

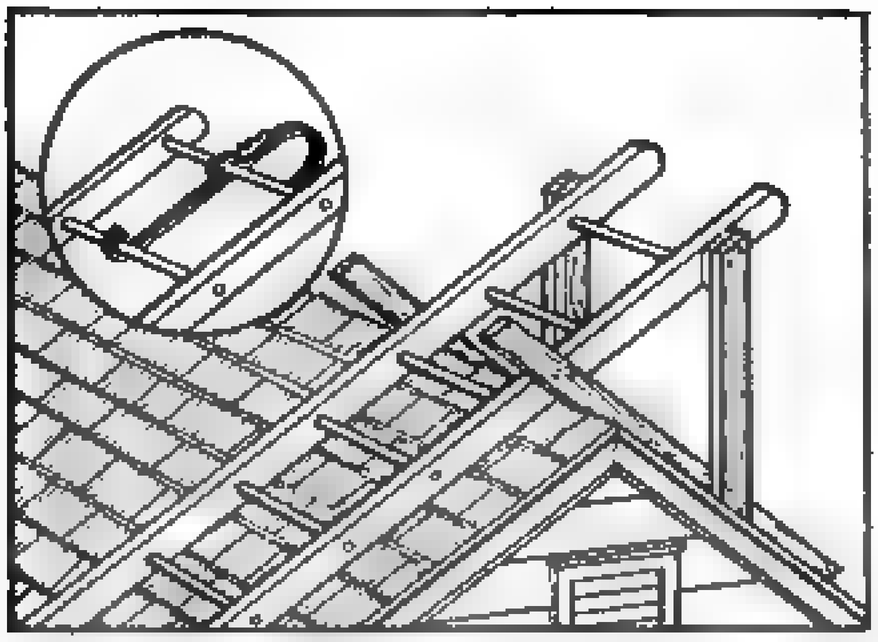
At the top of the facing page are shown four of the more common types of asphalt



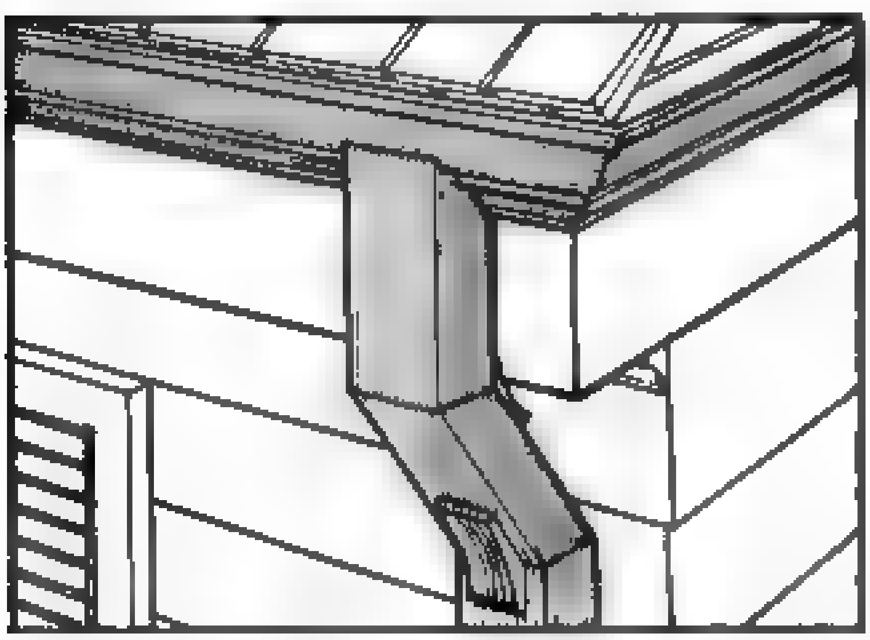
FOUR TYPES OF ASPHALT ROOFS APPLIED OVER OLD SHINGLES

METHODS OF APPLYING WOOD SHINGLES OVER OLD ROOFS





For safety in climbing a roof, use a roof hook on your ladder, or make one such as that shown above



New redwood gutters and leaders are good for many years. Blocks reinforce elbows in the drainpipe

roofing, of which the most familiar are individual shingles laid vertically in the American method and horizontally in the so-called "Dutch lap." In the latter fewer shingles are required, but the American style provides considerably greater insulation. The Dutch lap requires only one copper clip per shingle, and clips may be difficult to obtain.

Also shown are the hexagonal strip and the interlocking staggered butt or square-tab strip shingles. Notice how each type is doubled at the eaves. Individual shingles are butted together for this starter course and underlaid by roll mineral-surfaced roofing, while the strip shingles are laid butts up for the underneath starting course.

Satisfactory as composition roofing is, it is interesting that the texture and quality of wood is so often imitated, which is the best tribute to the appearance of wood. In overroofing, wood shingles not only add greatly to the roof insulation, but they also actually make the roof stronger, as tests have shown. Wood shingles come in 16", 18", and 24" lengths and in random widths from 3" to 14". No shingles wider than 14" will give good service.

So-called "dimension" shingles or uniform width shingles can be purchased too; 16" and 18" shingles are manufactured in 5" or 6" widths, and 24" shingles in 6" widths. Obviously, such a selection is expensive and is really less artistic in the opinion of many architects. It can be readily appreciated that 24" shingles of the same grade would cost more than the shorter lengths, but the longer the shingle, the fewer required per square, hence installation costs less.

At all points on a wood shingle roof there should be at least three thicknesses of wood so the "weather exposure," which is the distance from the butt end of one shingle to the butt end of the shingle above it, must be less than one third of the length of the shingle. Maximum exposures are calculated as being $\frac{x-1}{3}$ (x being the length of the shingle in inches). The exposure of a 16" shingle would therefore be 5". But if the roof pitch is less than one third, the exposure should be less by about 1¼". A normal roof pitch is one-half pitch or 45 deg. One-quarter pitch would be 22½ deg.

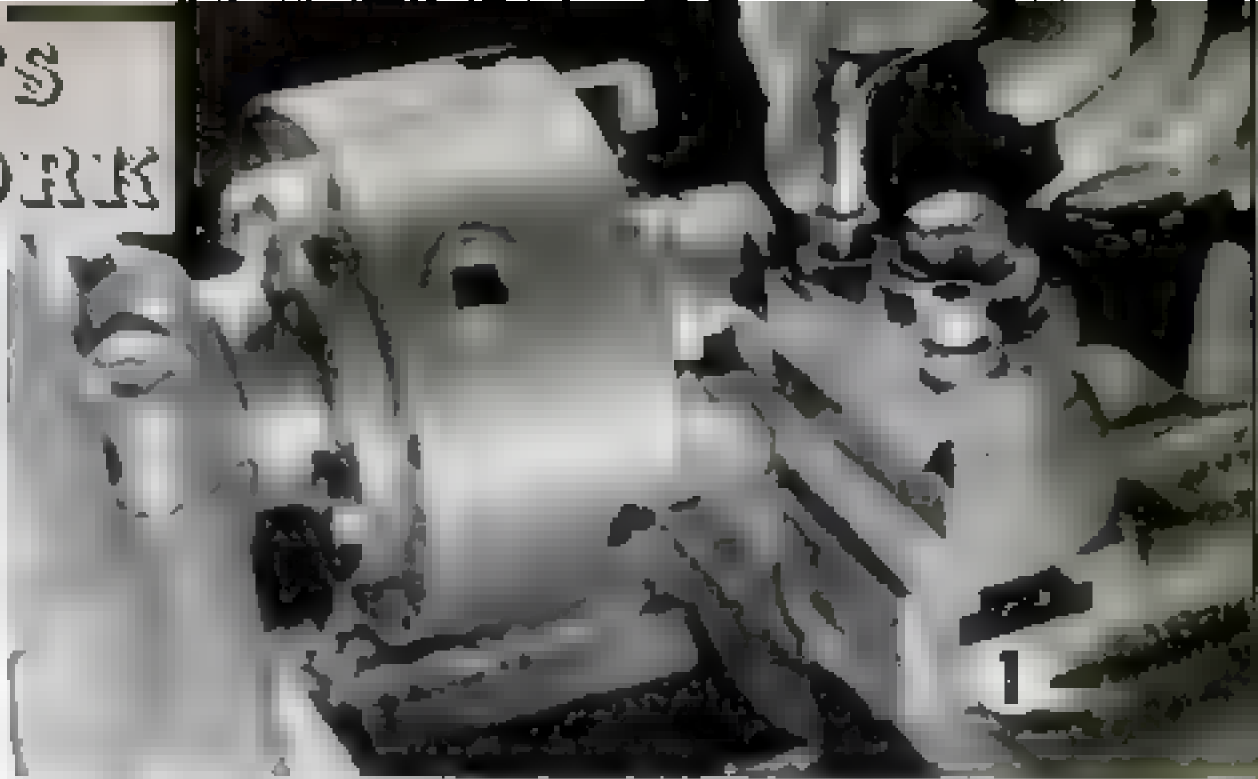
Wood shingles come in a number of grades developed by the Bureau of Standards, depending on whether the shingles are edge grain and heartwood and of proper width and thickness. This subject is too complex to be discussed here, but if you are considering wood shingles, learn the difference between grades. Their grade names in most cases are poor clues. Prestained wood shingles can be purchased. If you buy that kind, be sure of the wood and grade. Staining can subdue the appearance of defects.

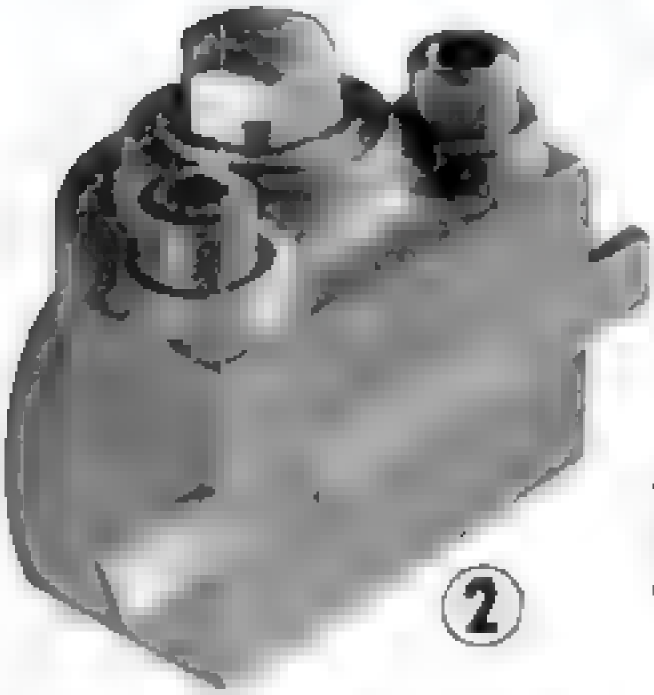
At the bottom of page HW 197 are shown details for applying wood shingles. They can be applied over old roofs without the leveling process previously described for composition shingles. No waterproof felt is needed, either. Wood shingles can be applied over composition shingles as well as over old wood. However, they are not fireproof and their use is prohibited in some congested areas.

Wood shingles for roofs should never be painted, but they can readily be stained. The best results are obtained by dipping them in stain or a composition containing creosote, with or without the use of pressure to cause greater impregnation.

These few facts about roofs are but high lights of a most interesting subject. You are likely to reroof only once, so be sure that the roof you buy is the best in durability, appearance, installation cost, and insulation that you can afford. Study the claims and counterclaims of every manufacturer before making the important choice.

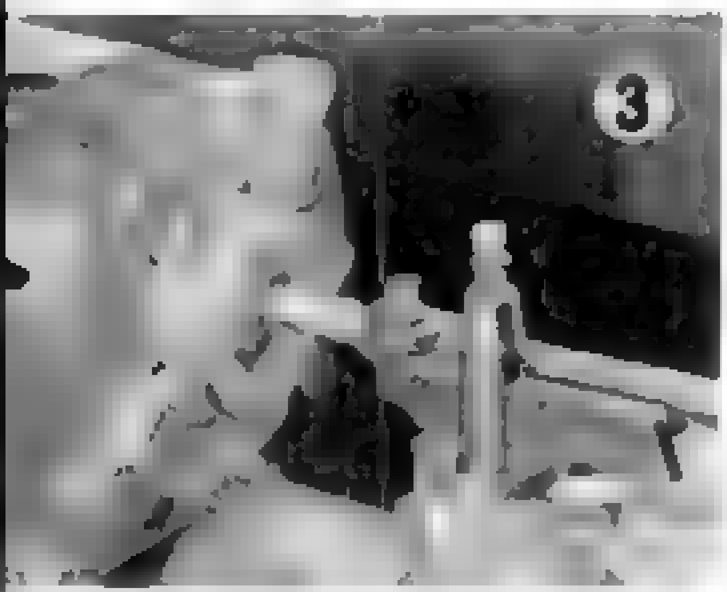
MACHINISTS FOR WAR WORK

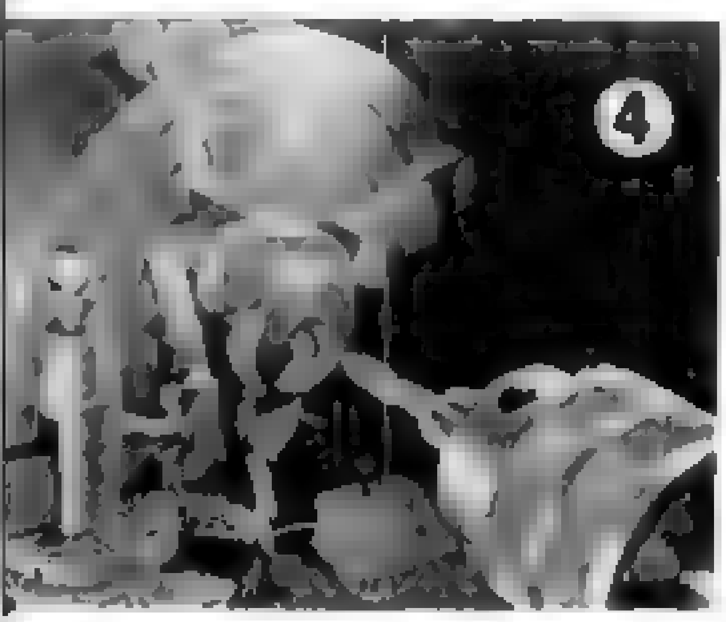




Parting-Tool Holder

By C. W. WOODSON



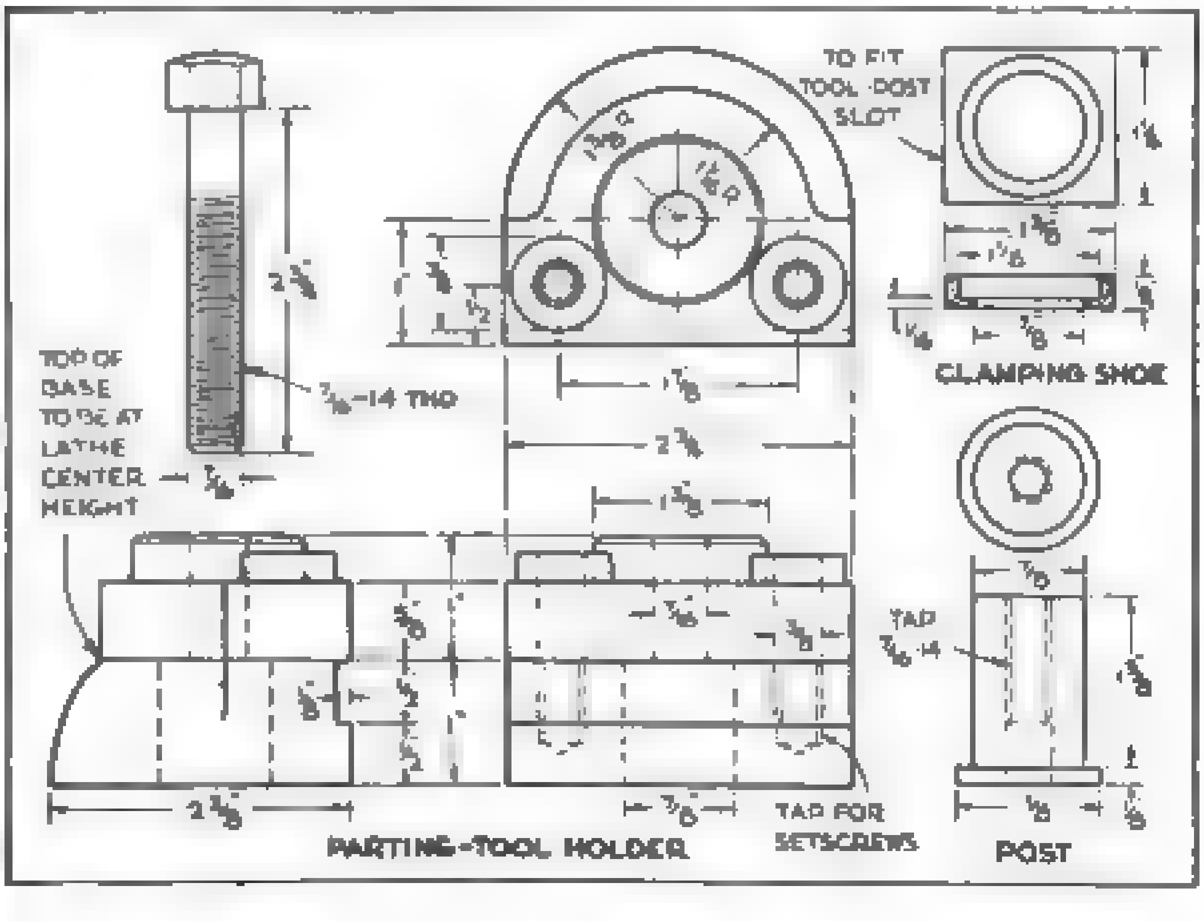


CUTTING off work, generally regarded as one of the more difficult of lathe operations, can be made considerably simpler with the sturdy tool holder shown in Figs. 1 and 2. It enables the parting tool to be used very close to the chuck jaws, and grips it so firmly as to eliminate any tendency of the work to climb up on the cutting edge.

Although the original holder was made up from iron castings, it could as readily have been made from steel blocks. The dimensions given are for a holder to be used on a 9" lathe. To adapt the design for other lathes, all that need be changed is the size of the post and clamping shoe and the height of the base.

The base casting was chucked and faced top and bottom to a size bringing the top to lathe center height when the piece was put on the compound rest. A boring tool was used to bring the post hole to size (Fig. 3) after it had been drilled through.

In its turn, the cap was faced off top and bottom and the large bolt hole drilled in the lathe (Fig. 4). On the drill press, two holes were drilled to a clearance size for 3/8" hollow-head clamping screws, as in Fig. 5.



The clamping post was made up from steel bar stock to the dimensions shown and the square shoe was bored to fit over it, being made a free fit in the tool-post slot. The large clamping bolt was obtained from an automobile junk pile, and the threads run farther up with a die.

The clamping post and bolt were then used to lock the body pieces so the two small holes in the cap would aid in spotting those in the base. After these were drilled and tapped, the setscrews were put in to hold the two parts together and a facing cut taken in the shaper (Fig. 6) across both end surfaces at once.

The tool slot was carefully laid out on the base, and this part alone was then clamped in the shaper vise as shown in Fig. 7. As this slot was cut 1/32" narrower than the body of the parting tool, the latter projects that far above the top surface of the base and is firmly clamped by the cap. Figure 8 shows the finished parts.

Planer Jacks

MACHINISTS FOR WAR WORK

FOR machining castings or other work that is apt to be sprung by the pressure of a planing tool, and especially for supporting projections of irregular pieces, the jacks shown in Fig. 1 will prove useful. They combine ease of adjustment with great strength and straight thrust.

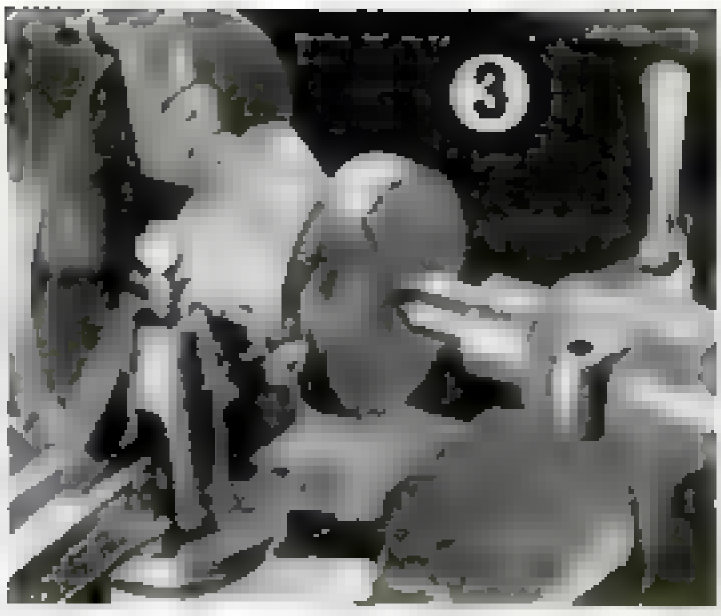
A complete set, which would include sizes from 1" to 12", could be made from iron castings or steel bar stock. The height can be varied without otherwise changing the design. A ball joint at the top allows the cap to bear evenly on the work, and the screw can be locked after adjustment.

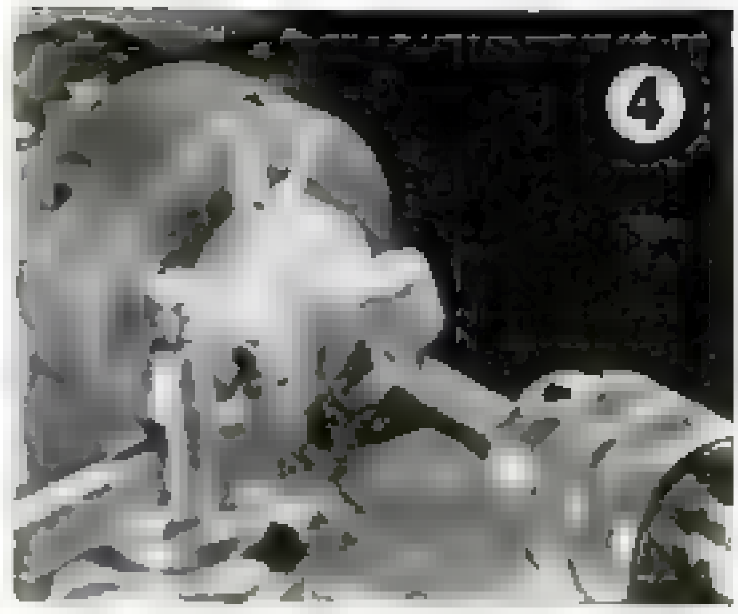
Being made of cast iron, the jacks illustrated required a pattern (Fig. 2). This was turned from cherry and notched for the clamping lug, which was glued in place.

With the center marked on the bottom with a prick punch, the casting was chucked in the lathe, a center hole drilled for tailstock support, and the base turned and faced true (Fig. 3). A ½" drill was then run in to a depth of 1¼", after which the hole was bored out to 13/16".

The casting was then reversed in the chuck as in Fig. 4, a ⅝" hole drilled through to meet the other, and the internal square threads cut with a specially ground tool bit, as shown in Fig. 5. Very light cuts were taken until a smooth thread of the proper depth was produced.

A slot was then cut



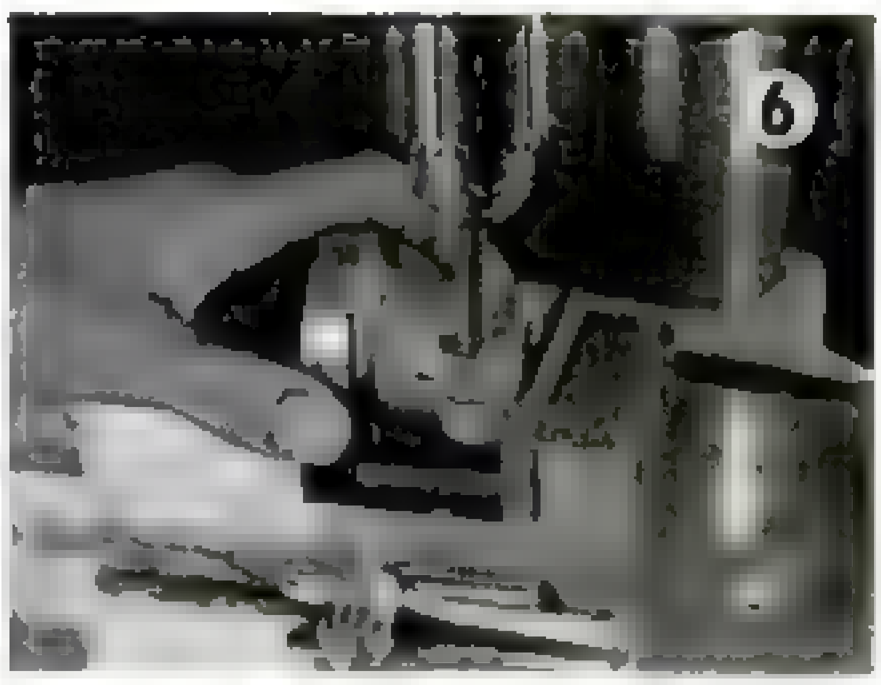


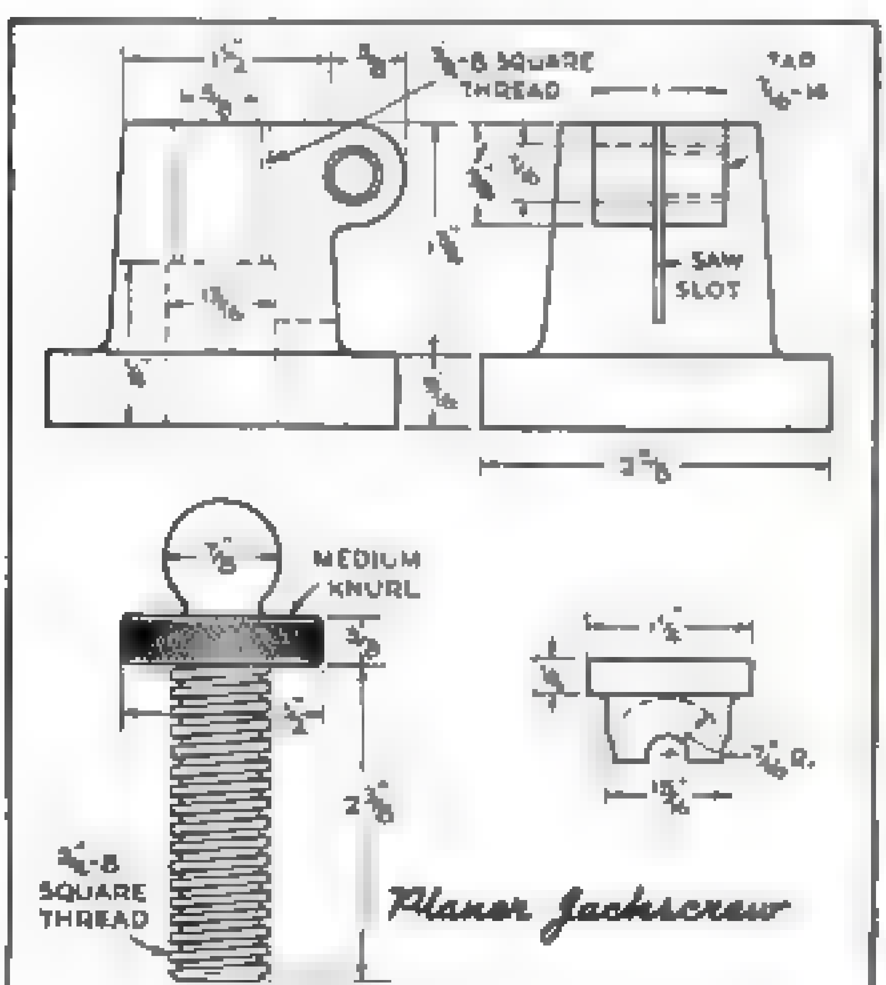
in the clamping lug and the screw hole was drilled. One half of this hole was reamed out as in Fig. 6 to clearance size; the other half was tapped for the 7/16" clamping screw.

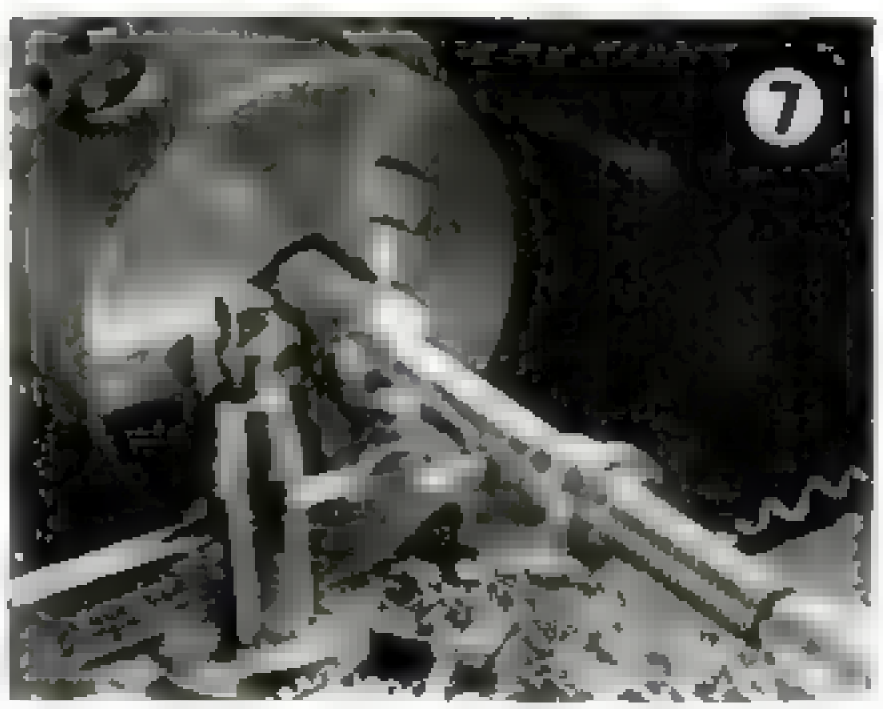
Two jackscrews were turned at once from a steel bar and the threads cut between centers as in Fig. 7, with light cuts and plenty of threading oil. A threaded casting was used as a plug gauge in making the threads a close fit, so that the parts would screw together by hand but without play.

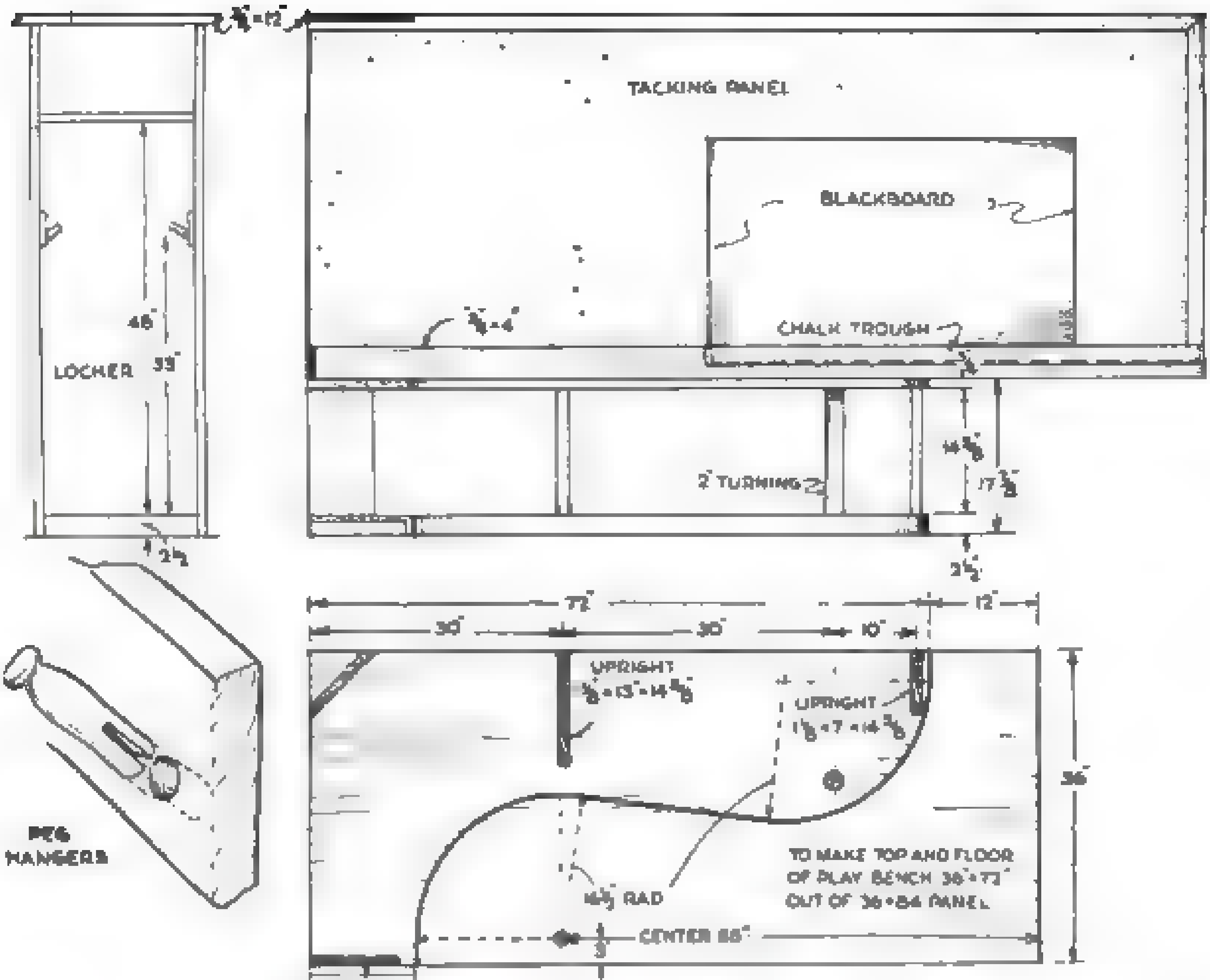
The screws were cut apart and reversed in the chuck for turning the ball ends. These were filed smooth and polished with emery cloth. Although a better job can be done with a ball-turning attachment, a template can be used as a guide for turning by hand.

Knurling the collars was the last operation on the screws, which were inserted as far in the chuck as possible for this job. Steel caps were turned, the edges filed to form prongs, and the caps attached by bending these prongs over the ball ends of the screws, as shown in Fig. 1.









Construction details for fixtures in a play room. Dimensions not given should fit the available space

Play Corner

By JOSEPH ARONSON

THE furnishings and equipment of the young child's room are ideal projects for the woodworking hobbyist of any degree of skill. The most elementary carpentry will produce efficient, attractive storage and play units of the type recommended by progressive educators specializing in child training. Some of their suggestions are incorporated in the corner sketched on these pages. Of course, these ideas will have to be governed by the dimensions and layout of the room you are working with, but a little study of the available spaces will show you how to adapt those features that interest you most.

Play bench. This unit is designed to provide a large surface off the floor. The space beneath is a "garage" or storehouse for such toys as cars, wagons, engines, boats, and the like, which are too large to fit conveniently on the shallower toy shelves. One of the drawings above shows how you can mark off the top and floor surface so that they may both be cut out of one 3' by 7' plywood panel without waste. The use of ¾" fir in this case is recommended. A covering of bright-colored linoleum for the top surface would make an ideal job, but would be an unnecessary expense on the floor. For the turned support you can buy a cheap rolling pin in the ten-cent store. It may be either doweled into the two surfaces or fastened with countersunk screws.

Tacking panel and blackboard. The largest size soft fiber panel your space can accommo-

Built-in play bench, tacking panel, blackboard, toy shelves, cupboard, and dressing closet make up this useful room unit

for a Child's Room

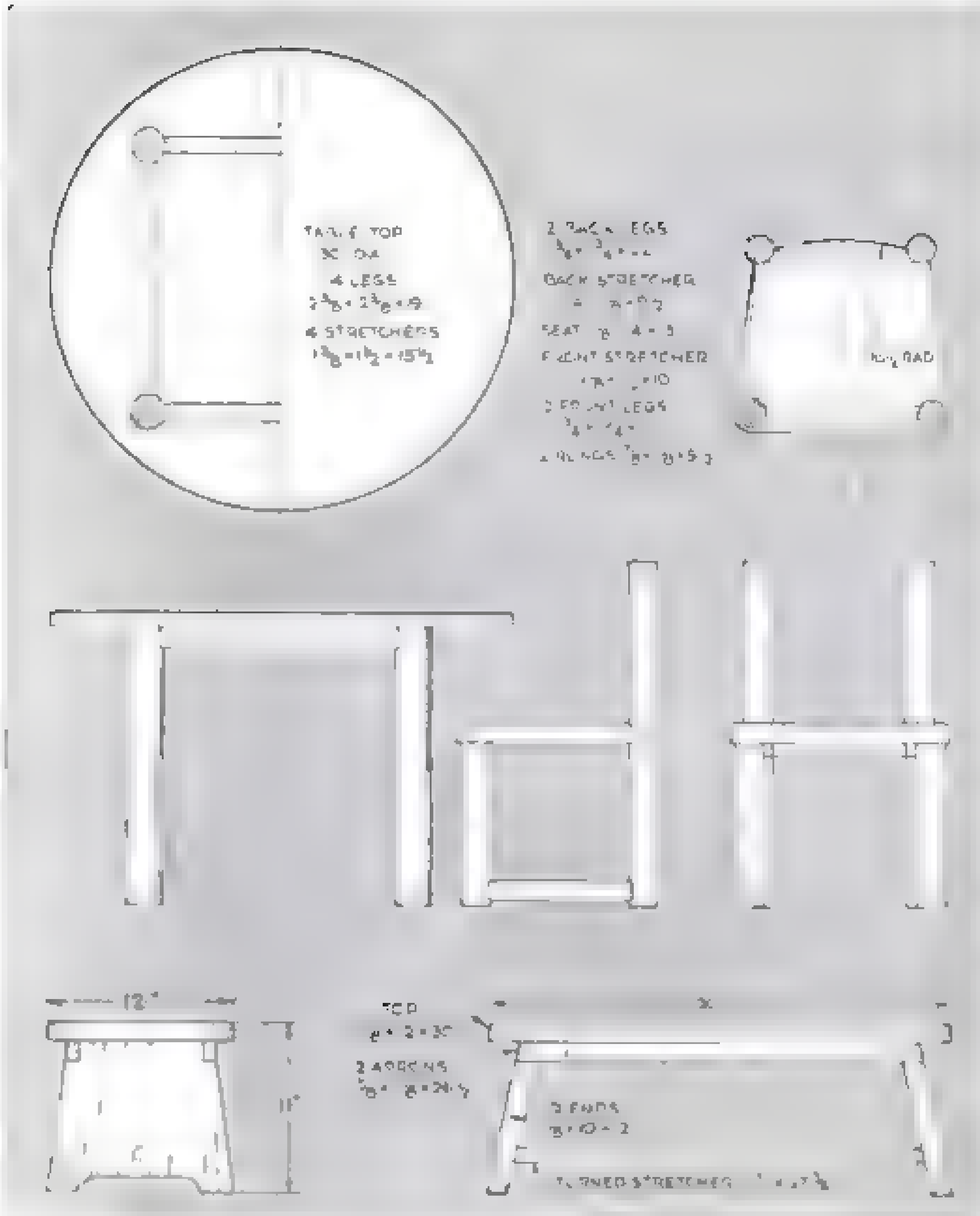
date is used as a wall board above the bench, and will give the child complete freedom in using thumbtacks to hang up drawings, pictures, and cut-outs with no damage to the permanent wall. This panel must be one of the soft boards which take thumbtacks easily without too much pushing. Several fiber products of this type are available for a choice.

A blackboard of large size should also be provided. Prepared blackboards are available, made of ⅛" hard composition board with a dull black coating. You can produce the same effect with a few coats of dead flat black paint on a similar panel.

In the drawings the main tacking-board is shown about 3½' high by 8' long, with another piece about 3½' by 3' at the corner. Both pieces are held against the wall by plain wooden moldings 4" wide at the base and about 1½"at the top and end. Under the blackboard is a boxlike chalk trough, part of which has a loose lid with holes large enough to hold jelly glasses, which will be found perfect for the large quantities of water colors children like to use. The chalk trough also serves as a resting place for a large pad for drawing and painting.

Toy cases. Shop pine in 12" widths, or fir plywood, can be made up into any combination of shelves and cupboards your ingenuity may dictate. A few ideas are offered which you may find convenient. Be sure to make the toy cabinet as large as possible, and try to keep a uniform top line. The top shelf in the corner illustrated extends over the play bench and tacking panels to emphasize this line, helping to smooth out the design and providing a high place of honor for a well-liked ornament or a favorite toy or two.

Among the toy shelves, have one or two half the depth of the cabinet to accommodate the smaller autos, airplanes, dolls, and such that otherwise would litter the larger spaces. One is shown in the sketch. It is so arranged between two shelves of



Fir plywood covered with linoleum forms the top of the table shown here. Stock for the turned legs may be glued up if the proper size is not available. For the chair back use leather, canvas, or any strong material in a continuous band stitched at the ends to slide on over the posts. Make the low bench of scrap wood

regular width that tall toys placed on the shelf below it will have plenty of extra space to stand upright.

A closed cupboard at the base is also a good idea, and sliding doors are preferred to hinged ones. You can make simple sliding panels of ⅛" or ⅜" plywood running in two sets of parallel grooves at the top and bottom. Make the grooves at least 1/16" wider than the thickness of the door panel so that the doors will slide in them easily without binding. It will also be a good idea to rub them down with paraffin. Knobs on the panels will provide a convenient grip for the child.

Locker. One section of the cases may be made into a convenient dressing locker designed to help the child form habits of orderliness. The space should be about 18" wide and 48" high. The child sits on a slightly elevated floor while pulling on his socks and shoes. For pegs, an amusing stunt is to use ordinary turned clothespins, cut 2½" long and driven into ½" holes bored on a slight angle. They give an attractive effect.

Table. According to many child experts, much commercial furniture for children is made too small. This, therefore, should provide the craftsman with an opportunity to produce a really superior article to be used for both play and eating. Suggested is the 30" diameter table, made of fir plywood with a linoleum top and legs turned out of 2½" stock, which may be glued up if this thickness is not available. The aprons are doweled or mortised into the legs, and the top screwed down from underneath.

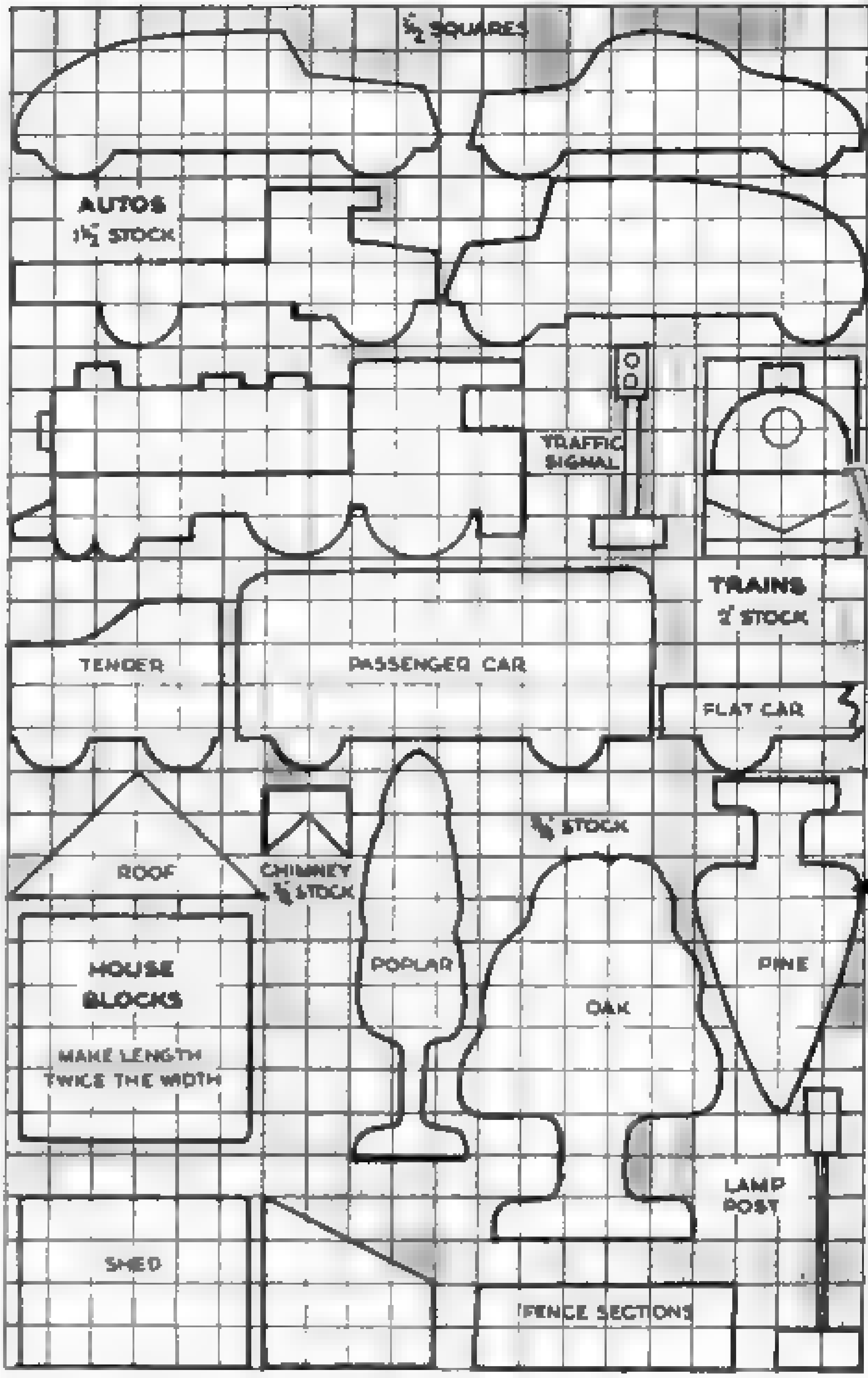
Chair. Posts turned from 2" stock form the legs. There are two cross stretchers each way, the side ones near the floor and those in front and back just under the seat. The seat is best made of 1¼" pine, which

you can shape slightly to get a comfortable saddle effect. The back is a wide strip of leather, canvas, or other material in a continuous band which slips over the posts. A row of rivets or stitching forms the tube around each post.

Bench seat. The low bench is useful for reaching up on the tacking panel, and children love to sit low. Make this of scrap boards. An old broom handle may be used as a stretcher.

Cut-out construction toys. There is free scope for the imagination in these simple band-sawed shapes that children can use to arrange towns and buildings. A few types suggested are trees, lampposts, traffic signals, cars, trucks, trains, hydrants, animals, and various shapes of building blocks for making houses, churches and the like. Paint them with bright colors.

Finishes. For the most part, natural wood finishes are preferred, if fairly clear stock is available, but they should be enlivened in places with bright color. The edges of plywood afford an opportunity for clear blues, reds, greens, and yellows. For the natural finish, the best treatment is a coat of one of the penetrating fillers, but even simple waxed effects are attractive.



Cut-out toys can be sawed from any suitable stock on hand. Lay out the designs on squares. Don't hesitate to include some original ideas.

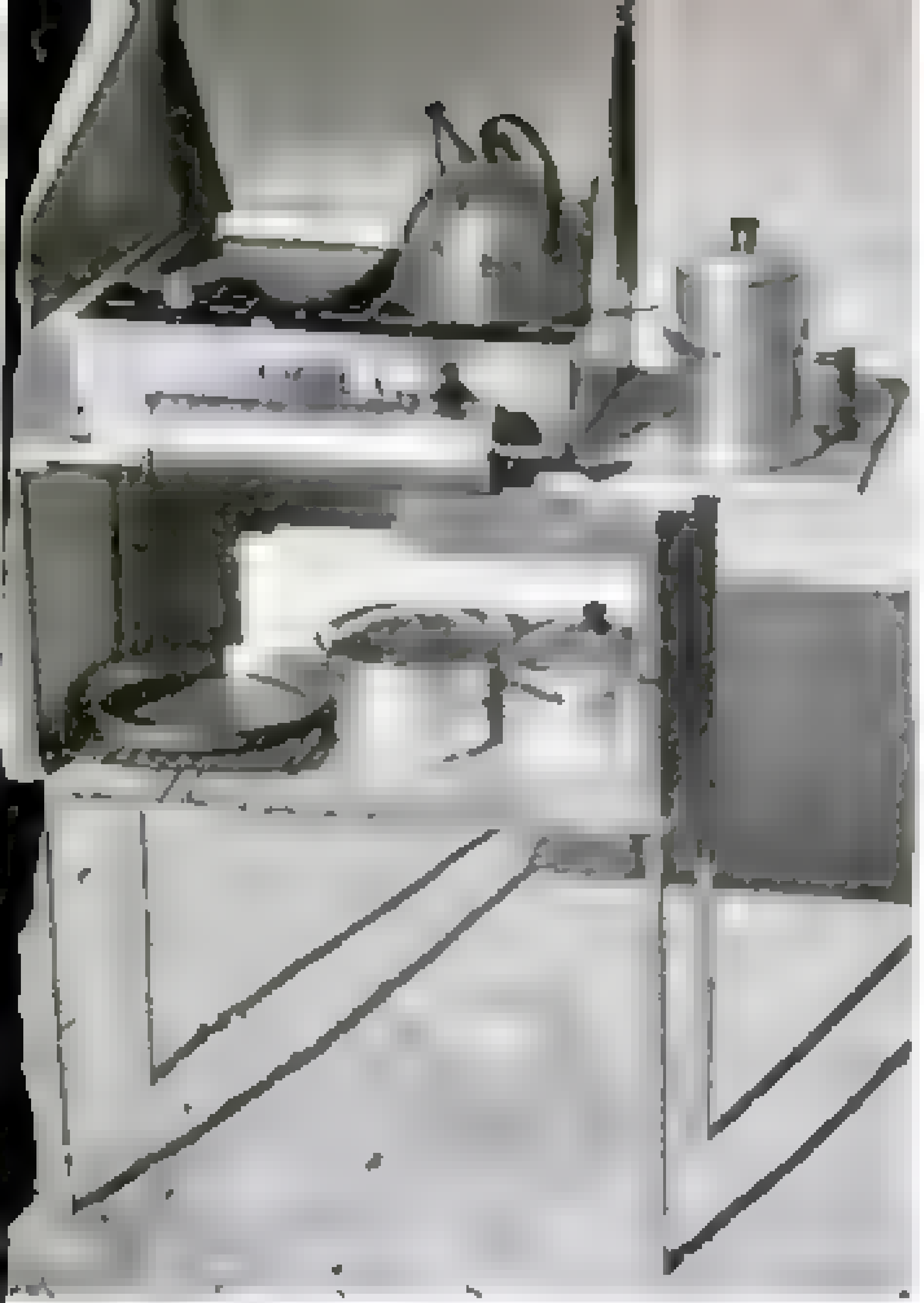
Costume Novelties Carved from Avocado Seeds

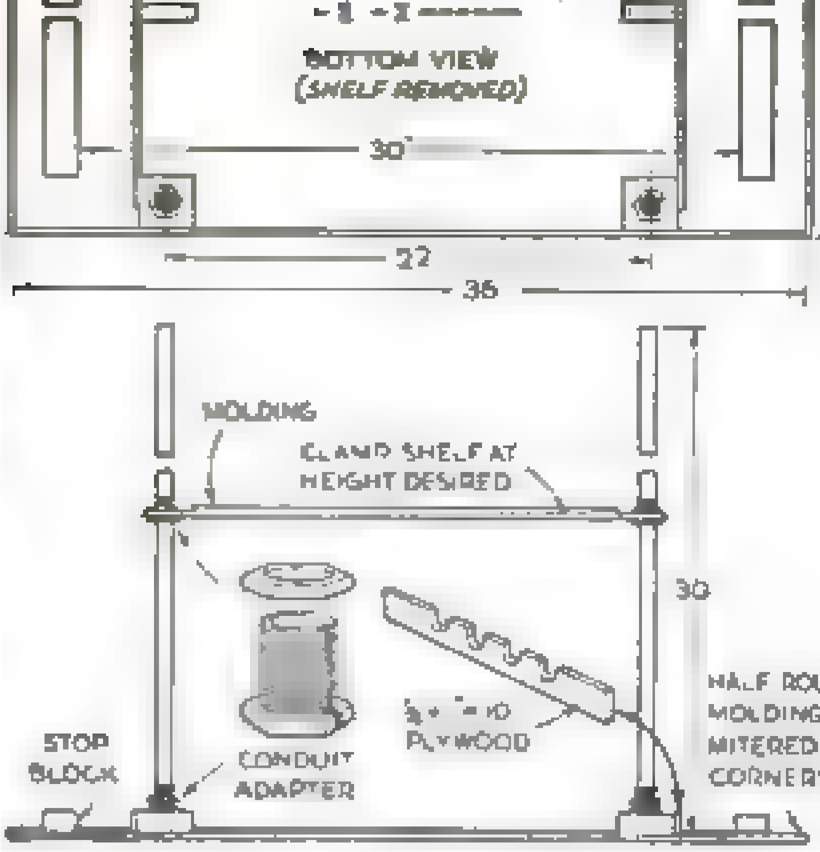
COSTUME novelties and heads for small dolls or puppets can be carved from avocado seeds. These have no grain and are soft when fresh, yet dry so hard that they can be sanded and finished like wood. The carving can be done with a jackknife, although a shallow ⅜" straight gouge and a small 3/16" veiner will come in handy.

Split the seed at its natural division and peel off the paperlike outer shell. Carve, sandpaper lightly, then hollow out the back, being careful not to get too close to the deepest cuts. If the hollowing is not even, the seed will warp in drying. In some cases, however, this is desirable for surprising and laughable distortions.

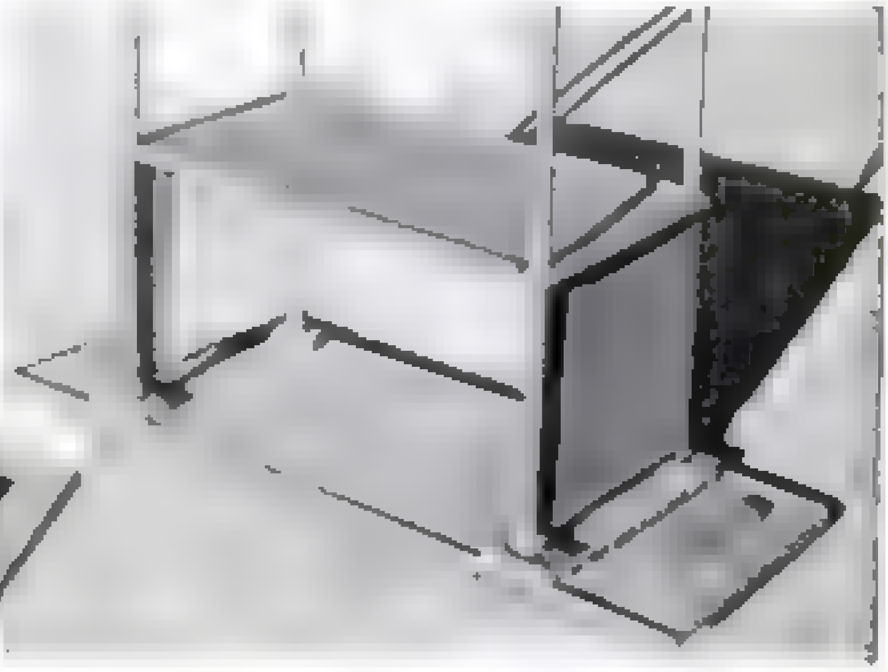
Place the hollowed seed on two small sticks to dry evenly for two or three days. Then sand and finish with a coat of lacquer sealer or shellac, followed by clear lacquer, oil color, or enamel. Fill the hollow back with composition wood and insert a clasp pin, screw eye, or any fitting desired.

For a doll's head, the process is the same, but two halves are carved, hollowed, and glued together.—CHARLES H. HUNT





Top and shelf are plywood, and the legs pieces of old conduit fitted into the wooden members with adapters, as shown in the drawing. A dustproof skirt for the cookstove stand is made of canvas



Packed flat, the unit takes little room in a camping kit

Portable Camp-Stove Stand

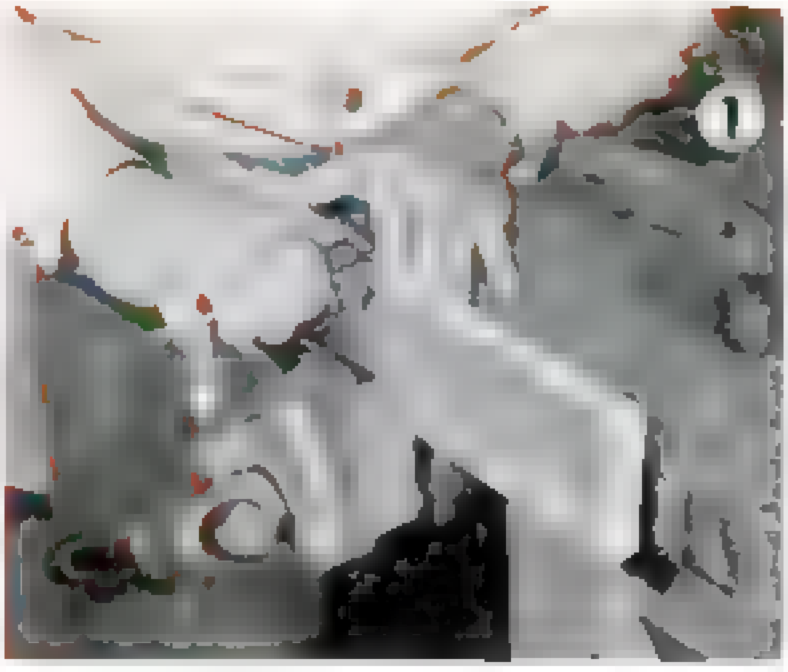
THIS camp cooking stand is really rigid, packs flat, has counter space on both sides of the stove and a shelf inclosed on three sides to protect food and utensils from wind-blown dust. A canvas flap can be added to cover the front also.

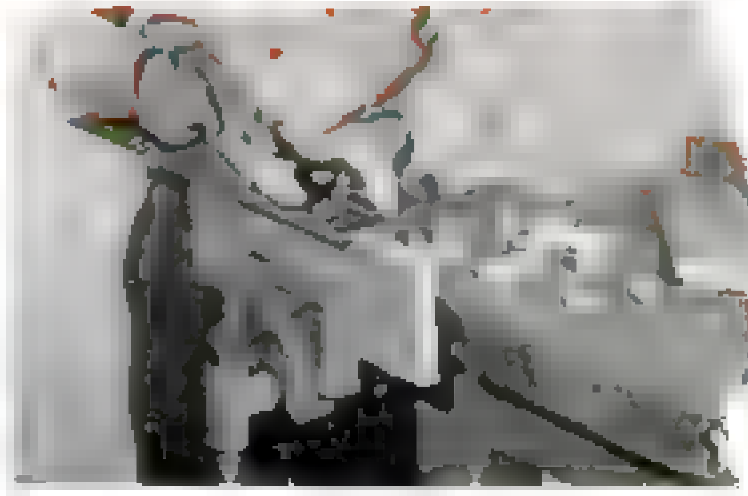
The top and shelf are of ¼" plywood, trimmed with ½" half-round molding. Four 1" by 2½" by 2½" blocks of wood, each with a hole into which ½" conduit will fit snugly, are fastened to the underside of the top with wood screws.

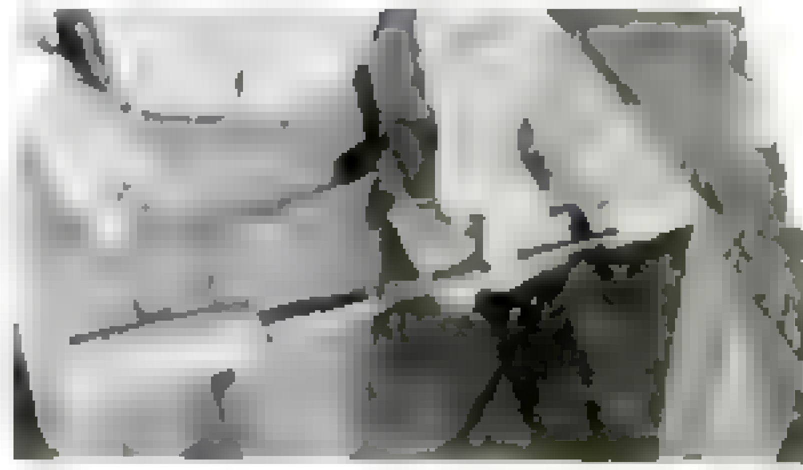
Used conduit can be bought at most wrecking yards. Four straight 30" pieces are needed, along with eight outside-threaded split collars or adapters such as are used for connecting thin-wall conduit to rigid conduit, and nuts to fit. Four adapters are fastened over the holes in the blocks with wood screws, which are set around the hexagonal flanges. A piece of conduit inserted temporarily in adapter and block will insure alignment. Four holes large enough to take adapters are bored in the shelf, so spaced as to correspond to the leg sockets in the top.

Notch two strips of plywood as shown, and screw them fast to the edges of the socket blocks. The legs are placed in these when the table is to be packed, and are held longitudinally by two stop blocks attached to the underside of the top.

The shelf skirt is of canvas, with sleeves at the ends through which the two front legs are slipped. To assemble the table, place a nut on each adapter, push the legs into the sockets, put on the skirt and finally the shelf. Tighten the adapter nuts to lock the legs and clamp the shelf at the desired height. Pieces of half-round nailed in front of and behind the camp stove keep it from sliding off. Knocked down, the parts can be held together with rubber bands cut from old inner tubes, or with ordinary luggage straps.—H. D. SMITH.







What's Wrong?

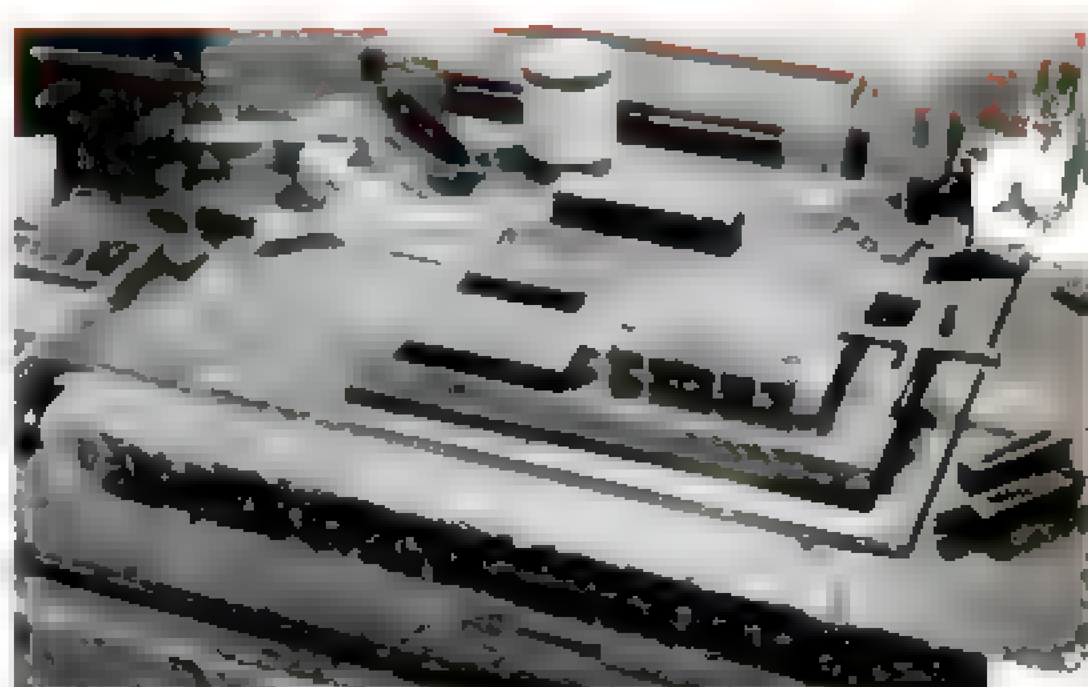
CAN YOU FIND FOUR WOODWORKING ERRORS?

HERE are illustrated three common benchwork operations—and four errors in doing them. Figure 1 shows a board being marked for a chamfer. There is just one thing wrong. Can you tell what it is? In Fig. 2, the worker is planing the edges of two boards that are to be glued together to form one wide piece. Can you name the two mistakes he is making? Then, in Fig. 3, the shoulder of a rabbet has been sawed and the waste is being chiseled away. What one error can you spot here? Turn the page upside down to check your answers.

* * *

WERS. 1. A pencil, not a marking gauge, should be used to lay out a chamfer, for the steel point would mar the finished edges. 2. (a) Boards to be glued edge to edge should not be planed separately. Planed together, the edges form complementary angles and make a perfect joint even if not exactly square with the face sides. (b) The worker is at the end of the bench and planing toward the foot. He would ordinarily stand at the right of the vise and plane the other way. 3. Waste stock should be removed by chiseling into the end grain with a wider chisel, held bevel down. The method shown is for finishing to a close fit.

Plate Glass Serves as Imposing Stone

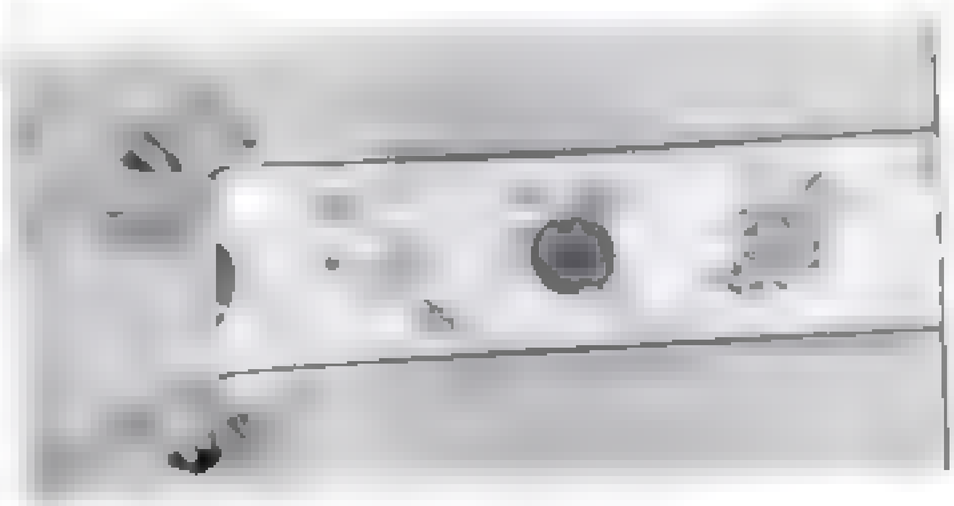


OWNERS of small printing presses will find that a piece of plate glass laid on a solid, flat surface makes a fine substitute for a marble imposing stone or a serviceable overlay for a stone that has become badly marred. The glass is relatively inexpensive and is easy to keep clean. When "planing down" type, it is more convenient to use than the back plate of the press.—L. A. L.

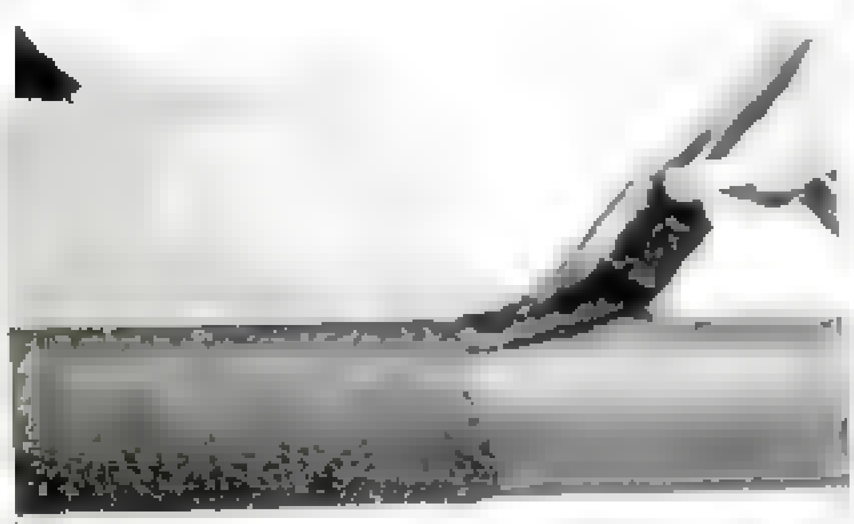
IDEAS *for* HOME OWNERS

WASHABLE WATER PAINT has been made available through recent development of synthetic resins. Applied to a wall, it dries through two separate processes—one, taking about an hour, in which the water it contains evaporates, and a second, requiring 48 hours, in which polymerization causes a change in the character of the resin base which results in a tough, waterproof surface. Wallpaper and other finishes, except calcimine, need no priming coat. The paint is sold in the form of a paste to be mixed with water in the quantity needed.

[AD]HESIVE DECORATING TRIM for use on [p]ainted or papered walls, around win[d]ows and doors, and on cupboards, fur[n]iture, canister sets, and other pieces is [a]vailable in rolls which may be simply [s]oaked in water and applied to the se[l]ected surface. The material is sunfast and washable. It will adhere to any normal wall covering or varnished or enam[e]led surface that is free from wax and [g]rease.



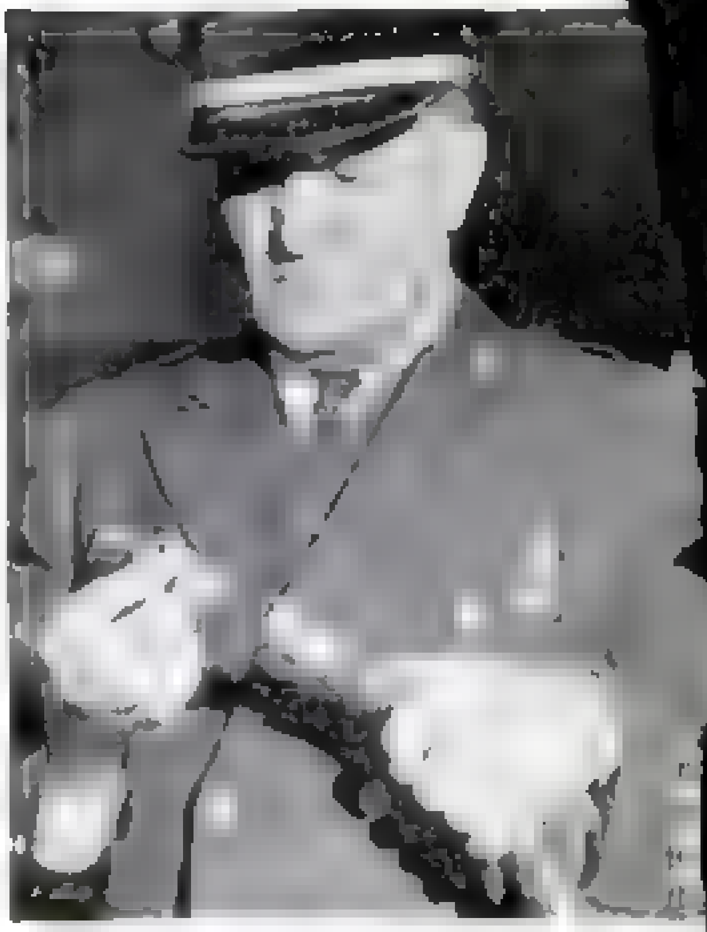
PLASTIC CORK COATING that can be applied with a paintbrush, whisk broom, or sprayer is used on pipes, walls, ceilings, tanks, and the like to prevent condensation. The coating is spread ¼" thick over metal, concrete, brick, plaster, tile, wood, composition, galvanized, or painted surfaces, and can be utilized in corners or on corrugated as well as flat walls. Its rough, stucco-like finish is suitable for painting.

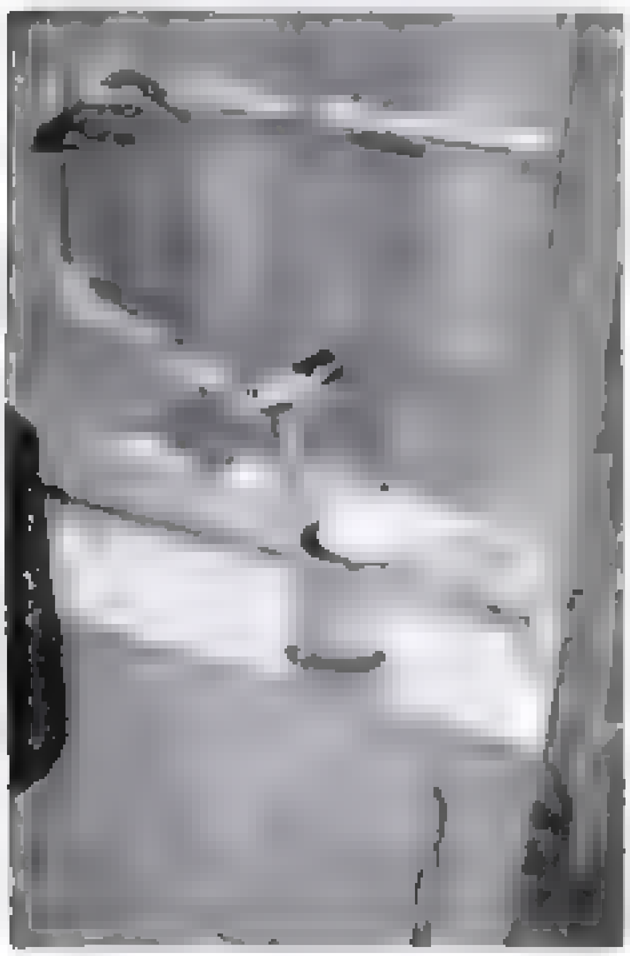


THIS GARDEN HOSE REEL is i[...] the basement ceiling and [...] entirely from the outside. C[...] to the water line is made w[...] basement, a valve-extensi[...] reaching to the outside ne[...] opening for the hose. In use, t[...] is pulled through its opening [...] length desired, and when the [...] kling job is completed, can be [...] in with little effort. The nozzl[...] at the opening to prevent theft. [...] are in two sizes—for 100′ a[...] of hose.

BLACKOUT ACCESSORIES FOR THE HOM[...]

EMERGENCY HOSE COUPLERS have been designed to permit the use of ordinary garden hose on any kind of household faucet. They are of special value when a connection is desired inside a house to a water outlet having no threads. As shown in the photograph at the right, one end of the coupler is threaded to attach to the regular threaded coupling end of the hose, while the other is equipped with a strong friction device to hold firmly to the outlet.





SHATTERPROOF LACQUER is now available for painting on window panes without obstructing vision or light. It is a flexible, clear, transparent lacquer that may be brushed on the glass from the inside and will take the place of strips or screening in keeping broken glass from flying. Three coats are required. The finish may be washed, and can be removed with a lacquer solvent or by scraping.

LOCATING OBJECTS IN THE DARK is helped by the use of luminous paper disks which may be attached to cellar steps, a fuse box, light switch, door knob, near a keyhole, or in some other place where a guide is required. Luminous paint that glows bright green in the dark and does not require previous exposure to light is used in the center of the disks, and is protected by a transparent covering from damage during cleaning and handling. The backs are coated with glue and, when moistened and pressed on, will adhere to any surface.

CCURATE
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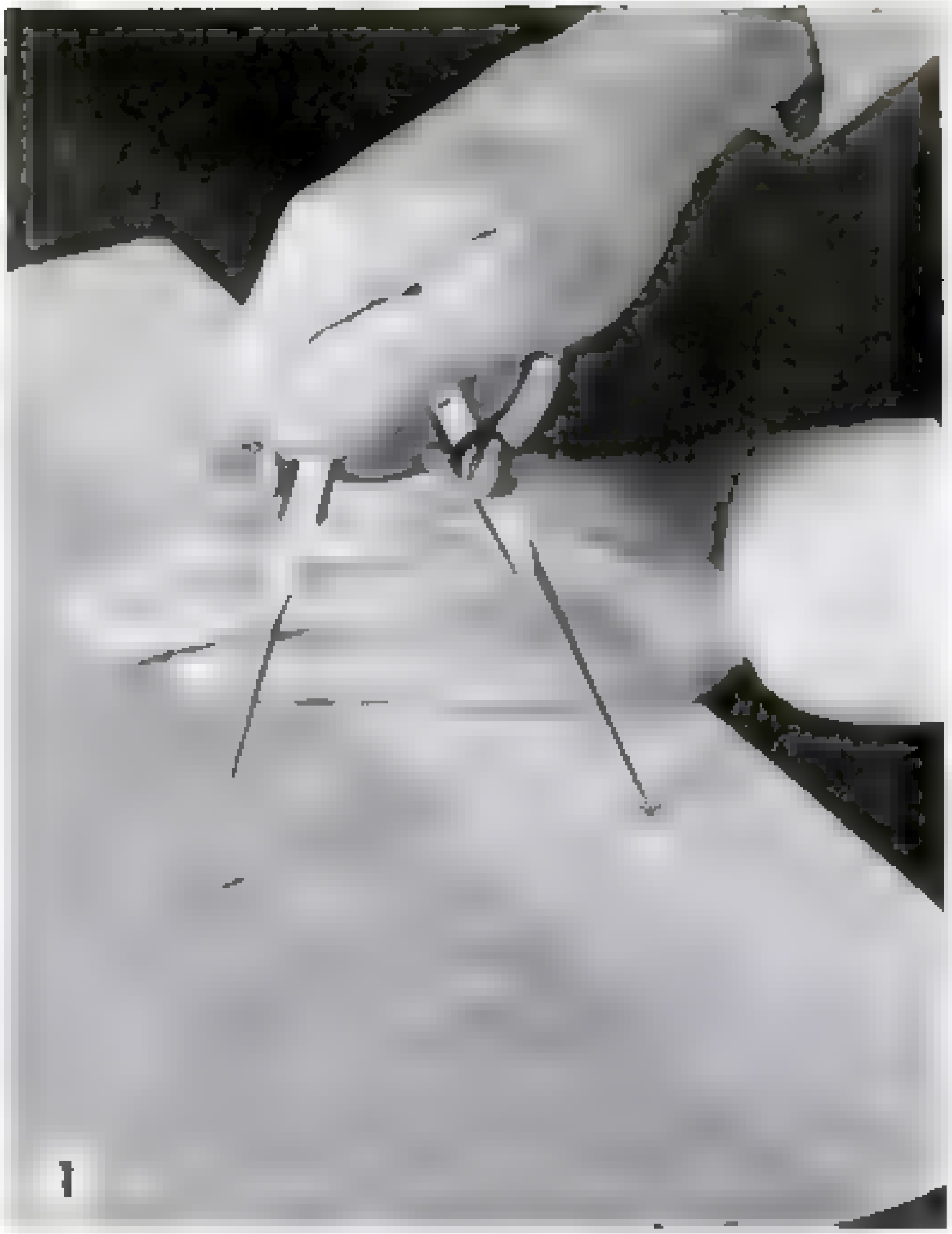
THE FOUNDATION
FINE WOODWORKING

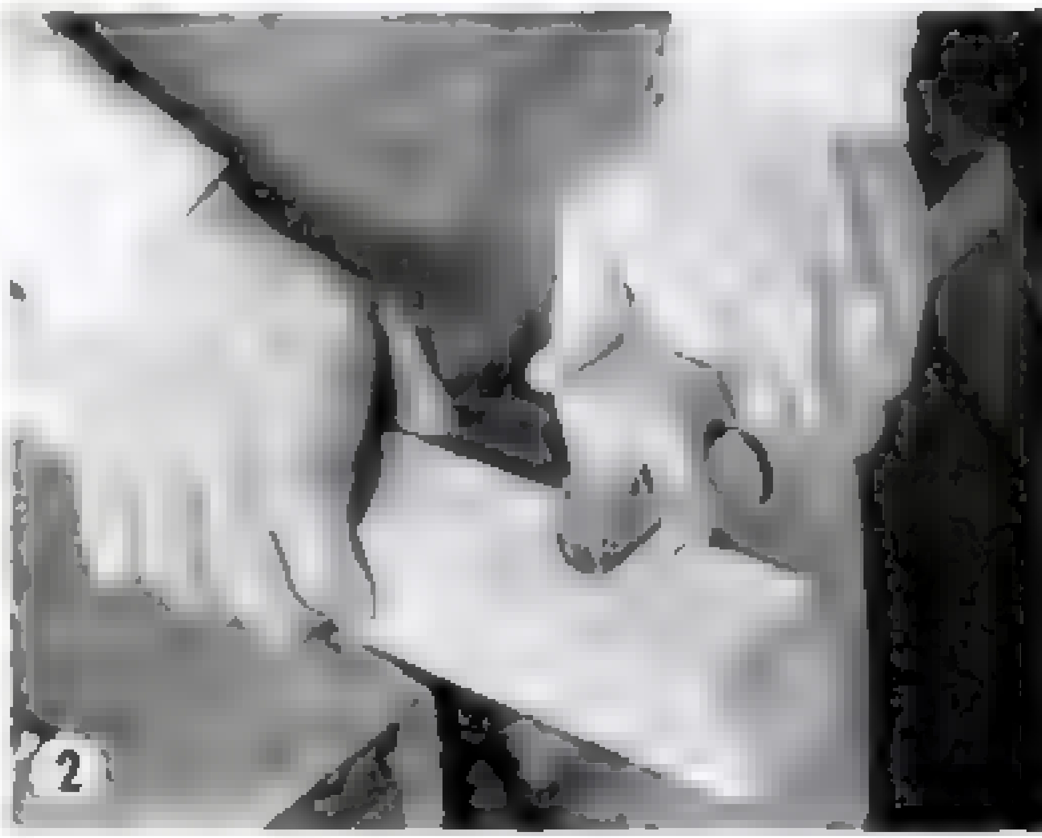
By
Edwin M. Love

RE than skill in using tools is involved in doing fine woodwork- So far as results are concerned, ng accurately to a carelessly n line is equivalent to missing a k that is accurately drawn. Care- laying out is, therefore, a prime uisite on almost any job, and a owledge of it is vital to the crafts- n who wishes to do good work in e shortest time possible without aste of materials.

In what ways can length be marked ff? For large, rough work, such as stic fences, hook the ring of a tape ver a nail driven in the starting oint, and mark the length with a eavy pencil. On small lumber, use a uare or a rule. For accurate cabi- twork, however, more care must taken. Either one end or one edge the board should be finished, or a ne accurately drawn to indicate a inished edge. Turn the rule or square n edge to bring the division marks lose against the surface, and use a sharp knife rather than a pencil to score the line. Measure from the 1" mark instead of from the end of the scale, which may be worn short. A fine-pointed hard pencil could be used, but since it becomes blunt quickly and is then worthless for exact work, frequent sharpening is needed. Too much reliance should not be placed in folding rules, as wear in the joints may stretch them.



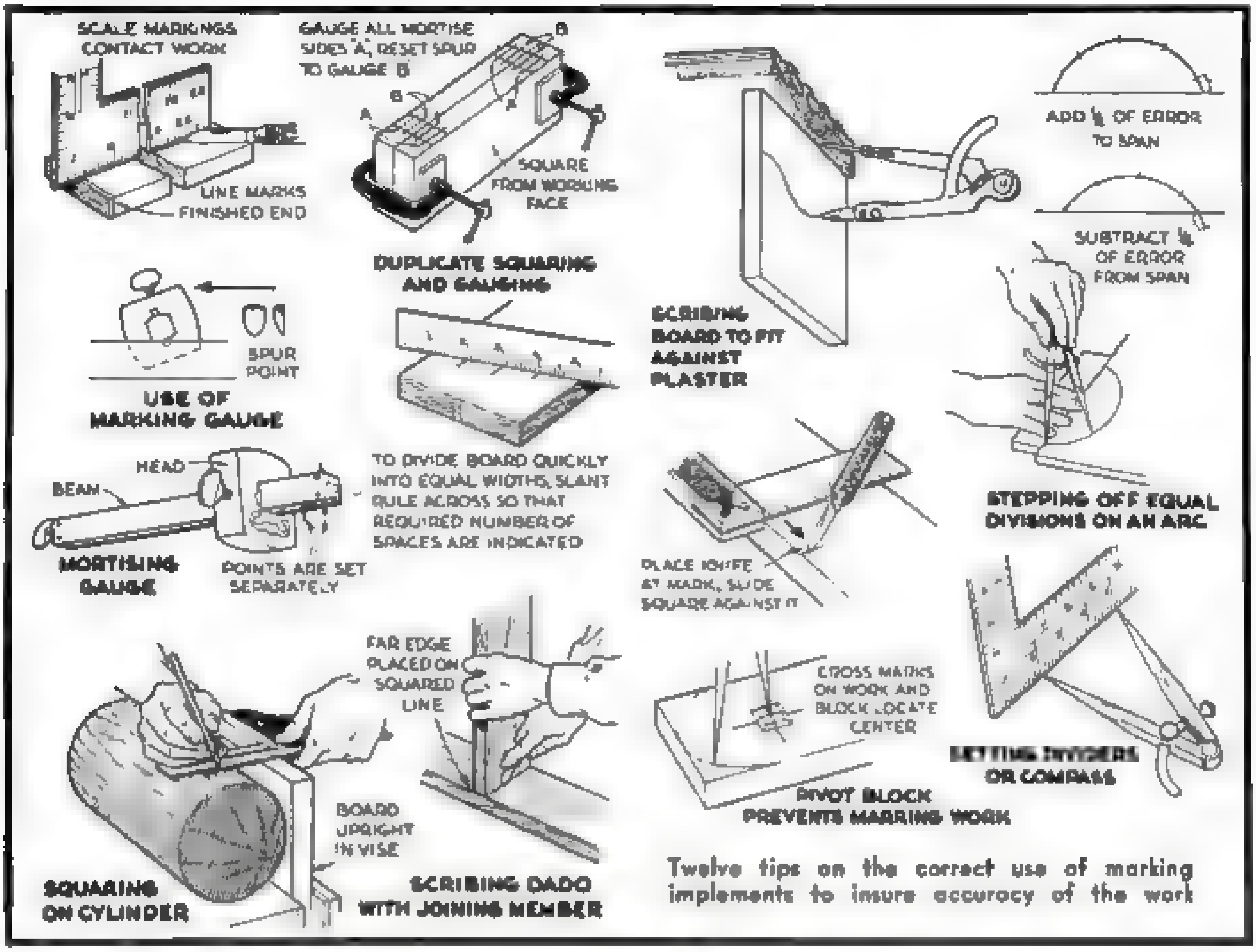
1



2

How is the width of a board gauged? Gauging can be done only if there is a straightened edge to work from. On rough work, the rule is often held in the left hand, which bears against the edge of the board, and is slid along the length of the board while the pencil is kept pressed against its end. A combination square (Fig. 4) is useful for gauging, the head being slid against he working surface of the material. With either method, be sure to allow for the fact that the pencil line is always a little distance beyond the end of the blade.

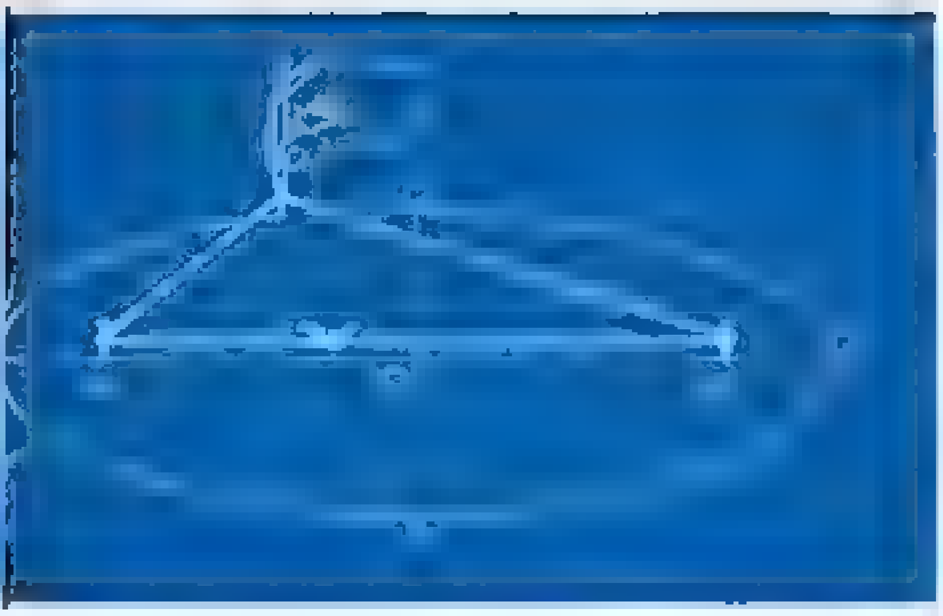
The marking gauge is an old stand-by for laying out widths. To set it, loosen the setscrew and move the head to the division mark on the beam; then tighten the setscrew and verify the setting with a rule, since resharpening may have displaced the point of the spur from the index line. The



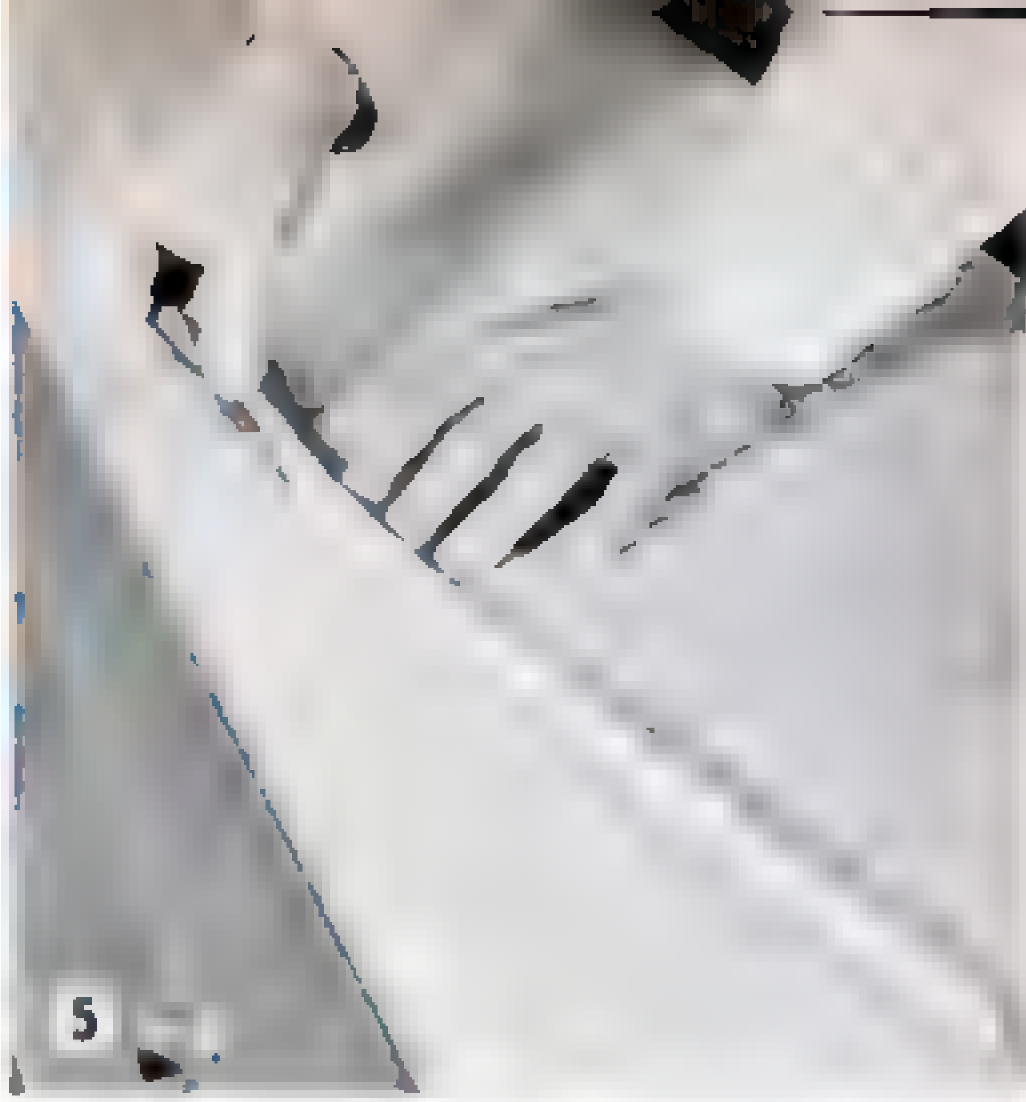
Twelve tips on the correct use of marking implements to insure accuracy of the work

usual method of using a marking gauge is to grasp the beam and head in the left hand, forcing the head against the work, and pushing forward. Roll the gauge slightly in the direction of its motion. Deepen the line with two or three cuts for which the spur is turned toward the vertical. No more than a fine, distinct scratch is required. Many times it is convenient to use the gauge in the right hand, and sometimes it is better to pull rather than push it, so that contrary grain of the wood will tend to draw the head against the working face instead of away from it. Figure 2 shows such a gauge being used to lay out a mortise.

What is the right way to square lines? Use a try square on small work, a framing square on large. The handle of the try square or the blade or tongue of the framing square is pressed firmly against the



In laying out an ellipse, first draw the major diameter AB and the minor CD intersecting at O. Set the compass to the radius OB, and strike arcs from D at F and F_1. Drive tacks at F, F_1, and D, stretch a string or fine wire around all three, and join the ends in a tight triangle. Remove the tack at D, and run a pencil inside the string. The pencil should hit A, C, and B

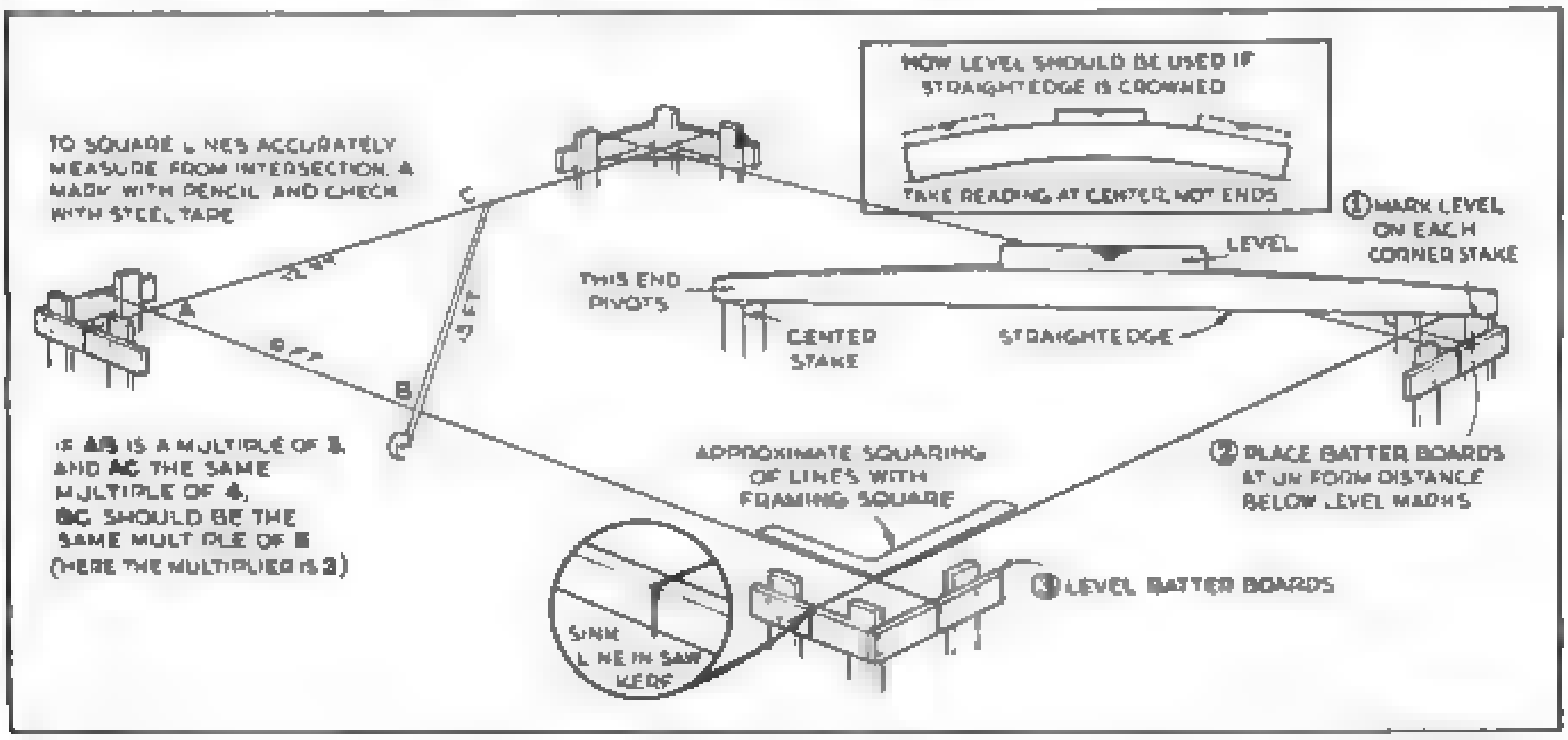


working edge. Since the outer edge of the framing square will be lifted from the board, the knife blade should be run along the inner edge, which touches the work. In squaring to a mark, lay the knife point on it and slide the square up to the blade.

How is a bevel square used? It is used like a try square, but, of course, with the blade set to the required angle. Use a protractor to set the blade by degrees, or a framing square as in Fig. 3, if the amount of inclination is given in inches per foot. Tables also are available for setting to degrees with a framing square.

What is the right way to lay out curves? Draw circles or arcs with a compass or wing dividers, setting the span of the points to the desired radius. Locate the center with cross lines, and if the surface is not to be marred, lay a thin piece of scrap down and press the compass point into this. To draw curves the center of which lies outside the work, clamp a board to the work, or lay the work on a bench against a scrap piece of the same thickness, as in Fig. 1. For drawing large arcs, a beam compass is used. Irregular curves can be laid out by marking off station points measured from a base line, driving nails at these points, and bending a batten against the nails to form a smooth curve, as shown in Fig. 5.

The dividers and compass are also useful for laying out geometrical forms. If a circle or segment is to be divided into equal parts,



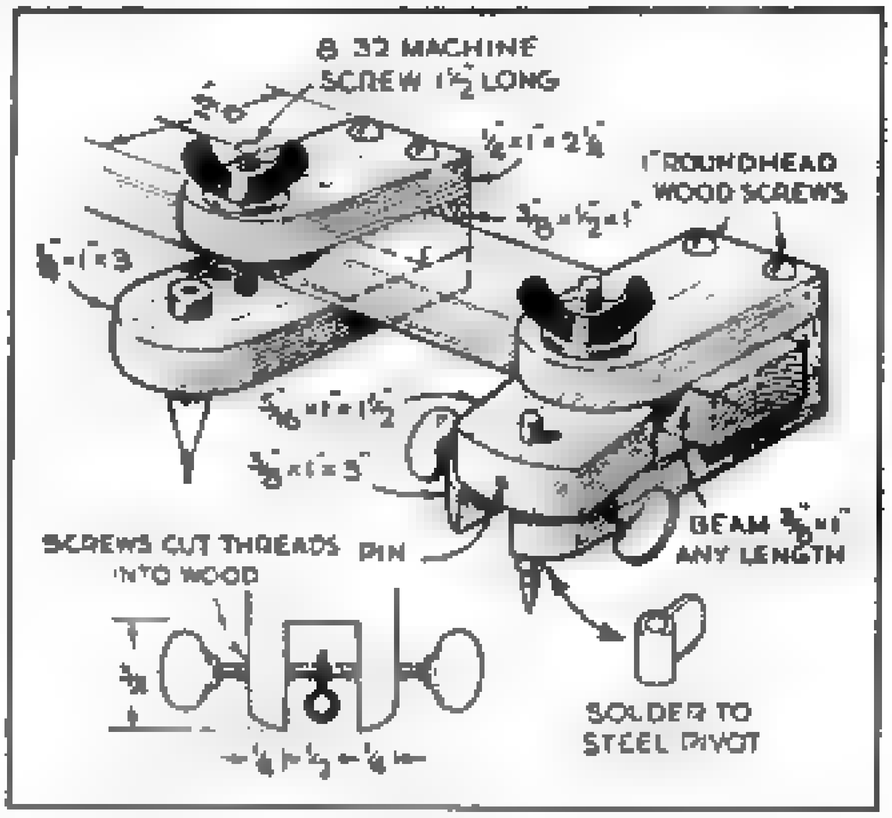
When leveling corners for a foundation, drive a stake at the center, as shown, and rest one end of the straightedge on it. The lines can be squared at the corners by applying a basic right-triangle formula

Easily Made Precision Beam Compass Is Useful Tool

EXCELLENT practice in handling measuring tools is gained in building this precision beam compass, which in turn is useful for drawing arcs of large radius. Both units are the same, except that the lower jaw of the pivot unit is slotted and the steel pivot is set in an adjustable block.

The two are slipped over the end of a beam and locked in approximate position with wing nuts. The pivot is then set accurately by loosening one of the small wing bolts and tightening the other. Solder a metal strip around the pivot as a rigid shoulder for the bolts to bear against. The 3/16" wing nuts will cut their own threads in the slotted jaw. Use a pencil or a steel scriber in the other unit.

Three beams should be made, 2', 4', and 6' long. Use hardwood for all parts.—E. M. L.



Pin the steel pivot so that it will not shift in its block. The block turns on the clamping bolt

these can be stepped off by setting the dividers approximately right, making a trial division, and resetting by adding or subtracting the fractional part of whatever error appears. Accurate results are often obtained more quickly this way than by using a protractor or making other calculations.

What is the layout operation called scribing? This is a form of mechanical tracing that accurately follows any irregularities in the pattern piece. When the side of a cabinet must be fitted against a wall, for example, scribing is used. Place the front edge of the board plumb by blocking the lower end, if necessary, and set a compass at the distance from the wall to the mark indicating the desired width of the side. Slide the scriber point against the wall, holding the tool horizontally, and the pencil will mark out a line following any irregularities of the wall.

How is a spirit level used? To level straight timbers, rest the level on the piece while the free end is brought into position. If the timber is crowned, place the level at the center, where it will be parallel with the ends. In the leveling of corners for a foundation, errors in the straightedge and the level and also in the reading of the bubble often result in missing the level of the starting point by a good fraction of an inch. Doing the work over again is the only remedy. However, if a stake is driven at the center, and one end of the straightedge rested upon it, the level can be used to mark all the corner stakes accurately at the same height, and all difficulty will be eliminated.

A quick way to check foundation lines for squareness is to use a steel tape and the basic formula that the squares of the sides of a right triangle, added together, yield the square of the hypotenuse. The figures 3, 4, and 5 express this relationship perfectly and are easy to remember. Mark from the intersection along one line to a distance that may be any multiple of three, such as 9'. Measure along the adjacent line to the *same* multiple of four, which in this instance would be 12'. If the lines are square, the diagonal measurement between the points marked will be the same multiple of five, or 15' in the example illustrated in the drawing at the bottom of the facing page.

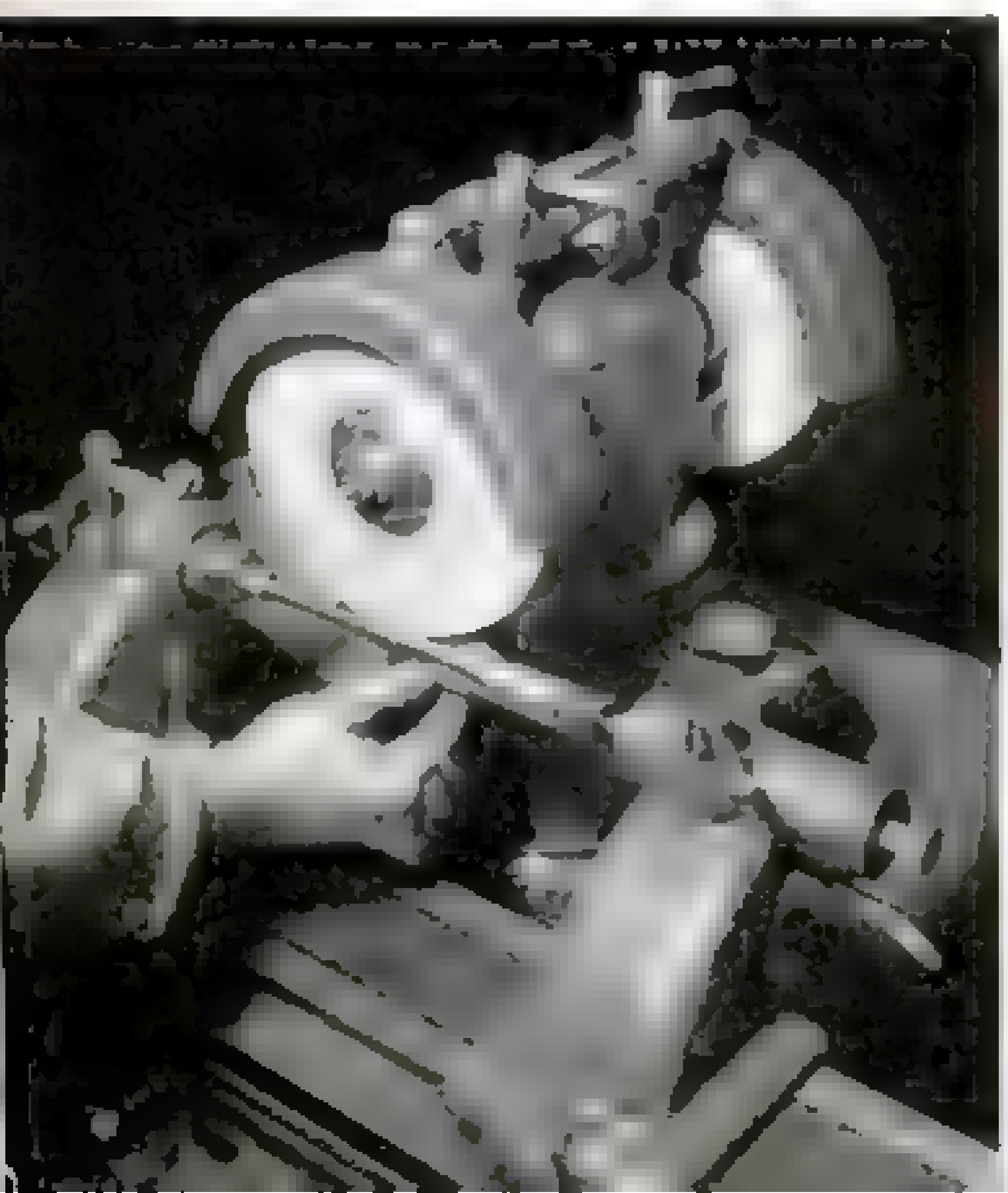
A straightedge is generally needed for outside plumbing. On indoor work, you can use the level or plumb itself for drawing short lines on walls, but for long ones, a straightedge must usually be employed.

What is a chalk line? This is a cord that is stretched taut between two points, rubbed with chalk, pulled away from the surface and suddenly released. Thus snapped against the surface, it leaves a deposit of chalk in a thin, perfectly straight line.

• • •

WHERE scroll-saw blades of several sizes are needed and frequently changed during the work, time will be saved by keeping them in common glass test tubes, for which a wooden rack may be made

Regrinding the flutes and "hooks" of a tap on two types of grinders. The chamfer, or point of the tap, is first to dull, and may be resharpened on an ordinary wheel or on one such as that at left on the machine above. As a rule, it alone needs touching up when resharpening, and the grinding of flutes should be avoided until it is necessary



Sharpening Taps

PAYS DIVIDENDS IN BETTER WORK

FEW tools are as likely to be used long after they have become dull as are taps. Because the actual cutting operation cannot be seen and the tool is confined by the work so that the cutting edges cannot spring away, taps are too often forced to remove metal when they are incapable of doing so properly. Any tap used after it is no longer sharp works under a great strain and is apt to chip or break, cut oversize, or produce rough, torn threads.

The simple and effective remedy, both in the large and in the small shop, is frequent resharpening. This will not only increase the life of a tap, but will also improve the quality of the threads it produces and result in threaded holes being of more uniform size.

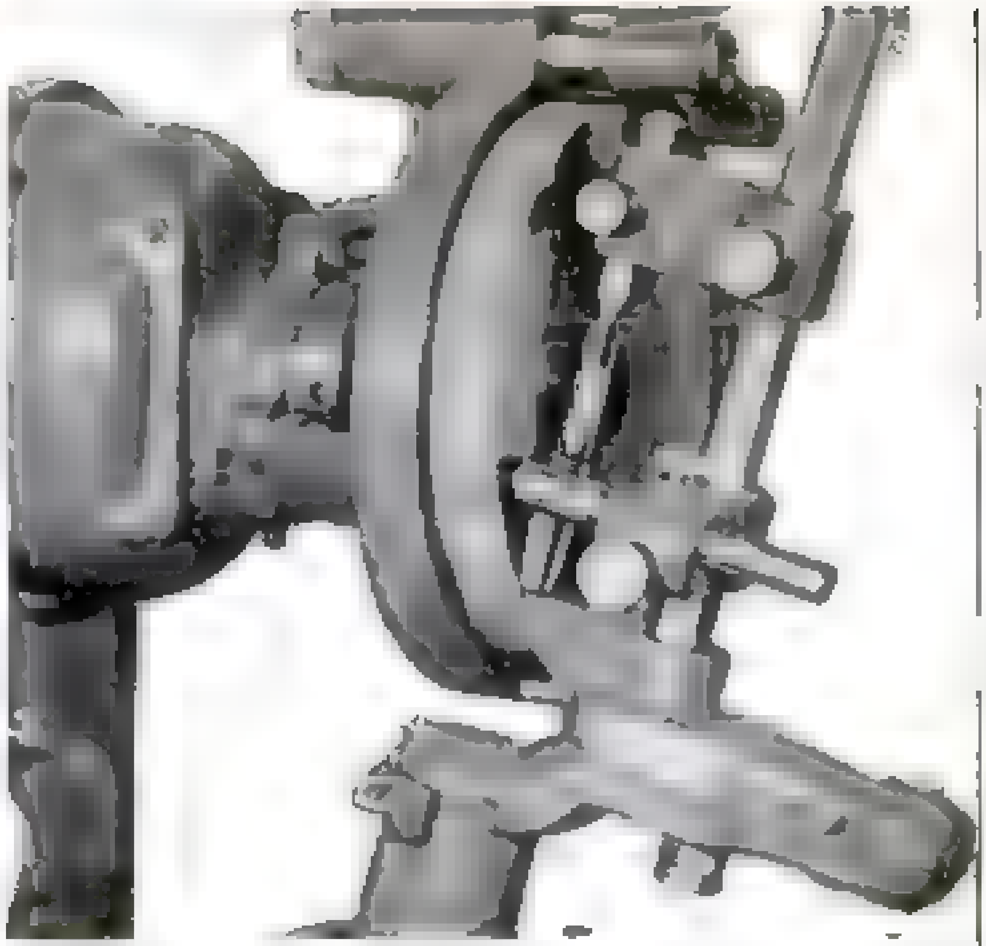
The following suggestions are based upon the recommendations of E. T. Larson in a recent article in "Grits and Grinds," a monthly technical publication of the Norton Company, and the illustrations are reproduced by courtesy of that magazine.

It is good practice to sharpen taps at the first signs of dulling, or, on continuous production jobs, at regular intervals determined by the number of holes tapped or the number of hours taps have been in use. Broken taps, too, can often be salvaged by trimming off the ends and grinding a new chamfer.

As the performance and life of a tap depend largely on how it is resharpened, it is advisable to do the work on a standard tap-grinding machine if possible. The setting for each size and lead of tap should be recorded so that the machine can be reset quickly for similar taps at any time. Taps sharpened by machine cut more easily, produce more accurate threads, and stand up longer.

Where taps must be sharpened by hand, care should be taken to reproduce as nearly as possible the original shape with respect to the number of threads chamfered and the angle and amount of eccentric relief back of the cutting edges.

Be sure you are using the proper grain and grade of grinding wheel. This is im-



Proper clearance on the chamfer will vary with the type of tap and material to be tapped. It should be sufficient to allow free cutting without binding

With this type of grinder, the tap is supported between centers for grinding clearance. Too little clearance causes metal to be "picked up"

portant. If the wheel is too hard and slow cutting, it may overheat and crack a tap. Vitrified aluminum-oxide wheels are suitable for grinding chamfers, squaring ends, and touching up the flutes of large taps. For grinding flutes on small taps, a rubber-bonded wheel is recommended. A shellac-bonded cutting-off wheel should be used for trimming off the ends of broken taps.

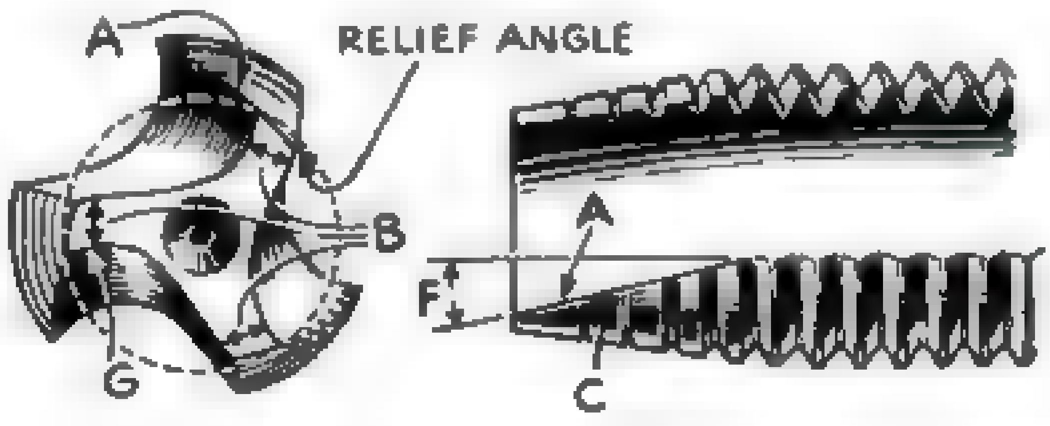
The chamfer or point of a tap becomes dull first, and as a rule it is necessary to grind only this portion in resharpening. Avoid grinding in the flutes unless absolutely necessary.

The proper amount of radial relief or clearance on the chamfer varies with the type of tap and the material to be tapped. The relief should be sufficient to permit free cutting without binding.

Insufficient relief will cause metal to be "picked up" on the outside of the chamfered threads; this in turn will weaken the cutting edge, especially if the tap has a hooked cutting face.

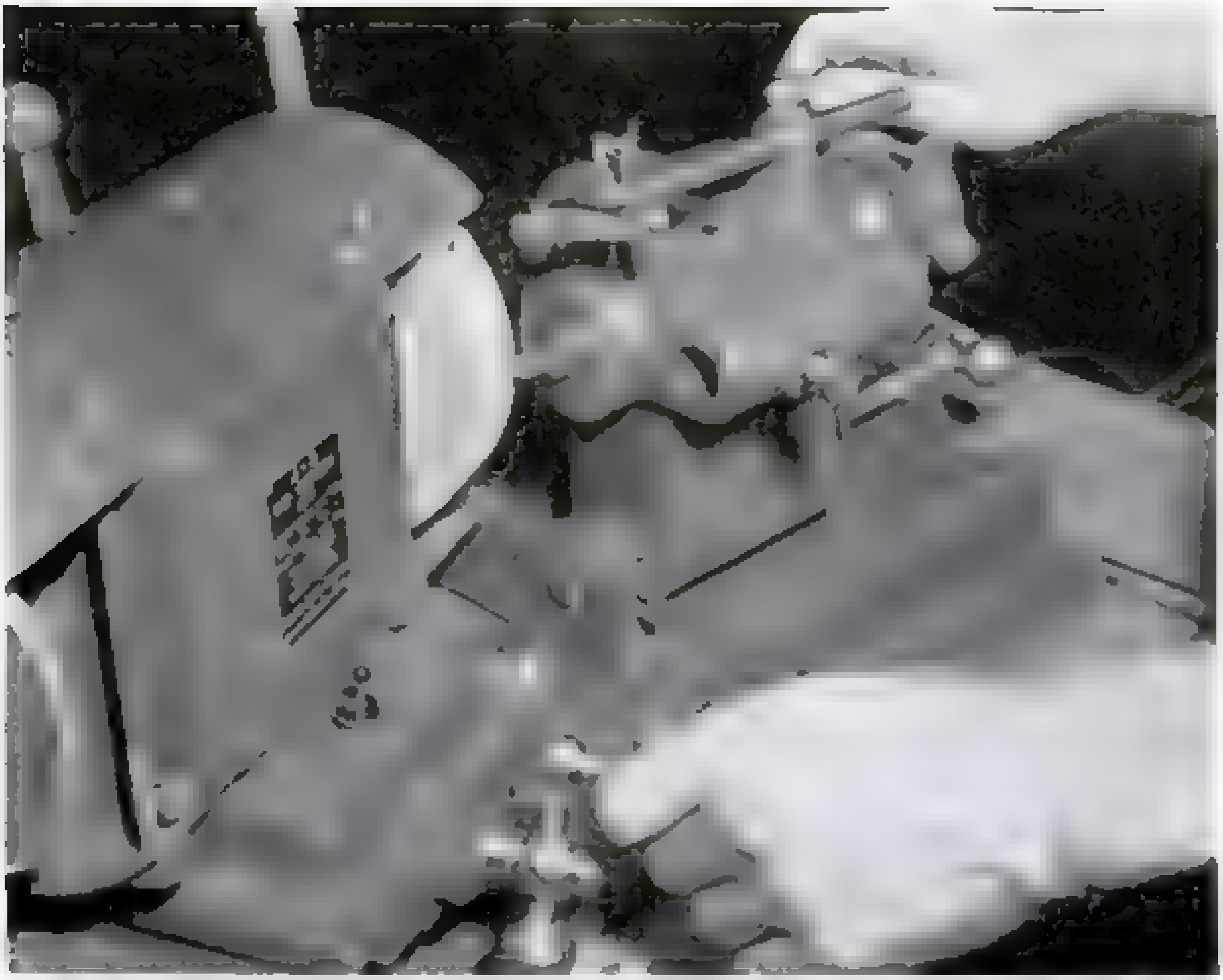
Be sure all the lands on the chamfer are of the same height. If they are not, a fewer number of threads must do all the cutting. The result is poor threads, oversize holes, and more likelihood of breakage.

If the edges of the teeth become dull or nicked, it is necessary to grind in the flutes. This may be done either by passing the tap



POINTERS ON GRINDING TAPS

1. Dress the grinding wheel to the exact form of the "hook" G.
2. Use a new tap of the same size for comparison in order to maintain the original form and angle of flutes and cutting edges.
3. When the ends of the lands B become narrow from repeated regrinding, dress the end of the tap straight back until they are again the normal width. Then carefully re-form the flutes, the cutting edges, and the hook G.
4. Maintain a straight cutting edge A and the shearing angle F.
5. Grind relief on the chamfers C so that the cutting edges A lie on the largest diameter, as shown by the circle, and the heels on a smaller one.
6. Remove only enough metal in grinding to sharpen the cutting edges.



Another, different style of tap grinder. Here the tap is supported on the outside of the thread close to the chamfer being ground. The locating finger helps in getting the correct position for the proper radial relief or clearance, and also can be used as a guide in duplicating the work

by hand against a grinding wheel having the face rounded to the radius of the flutes, or it may be done on a tap grinder, the tap being mounted between centers and moved back and forth against the wheel. To prevent the tap from turning, the back face of one land must be engaged by a stop of some sort.

When grinding flutes either by hand or in a machine, the grinding pressure should be very light and the wheel free and cool cutting to avoid drawing the temper and ruining the tap.

It is best to avoid, if possible, grinding beyond the chamfer in the flutes of taps that have radial relief back of the cutting edges, because as the latter are ground away, the pitch diameter of the tap becomes smaller and the tap will then, of course, cut slightly undersize.

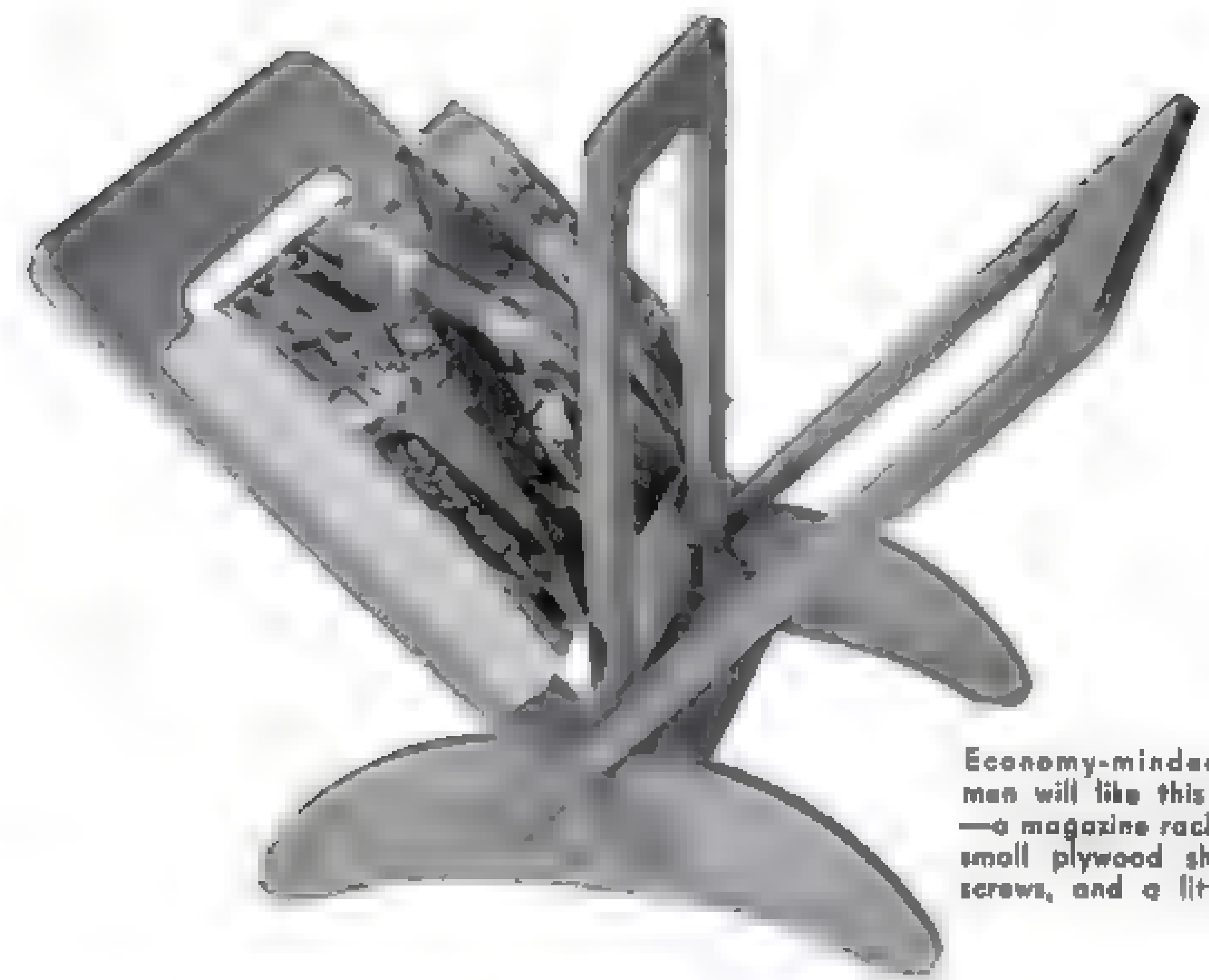
When the cutting face to be ground is radial or straight, a dish-shaped grinding wheel may be used. If the cutting face is hooked or curved, use a straight wheel with the periphery dressed to fit the contour of the flute

Should the work have a tendency to "load" the tap, it is advisable to polish the flutes after grinding. Broken teeth should always be completely ground away to prevent damage to the threads being cut.

Taps sometimes load or pick up metal, and as a consequence tend to produce ragged or oversize threads. With a triangular-shaped 400-grit diamond hone of the metal-bonded type, it is the work of a few minutes to clean such tap threads and at the same time burnish them to a high finish that results in smoother threads. The honing is done by hand with the tap supported firmly in a vise. A mixture of kerosene and cutting oil is brushed on the hone to serve as a lubricant.

Taps should be purchased with a flute and cutting-face design recommended by the manufacturer as being best suited to the particular material to be tapped.

The cutting faces of taps for cast iron, malleable iron, and brass are usually radial; however, a rake of 3 to 5 deg. is sometimes desirable. Such materials as cast steel, manganese steel, molybdenum steel, and vanadium steel will invariably tap better when the cutting face of the tap has as much as 10 to 15 deg. rake. Softer materials, such as aluminum alloys and certain stainless steels, require a 10- to 15-deg. or sometimes even a 20-deg. hook.



Economy-minded craftsmen will like this project—a magazine rack from a small plywood sheet, six screws, and a little glue

Magazine Rack and Unit Shelves

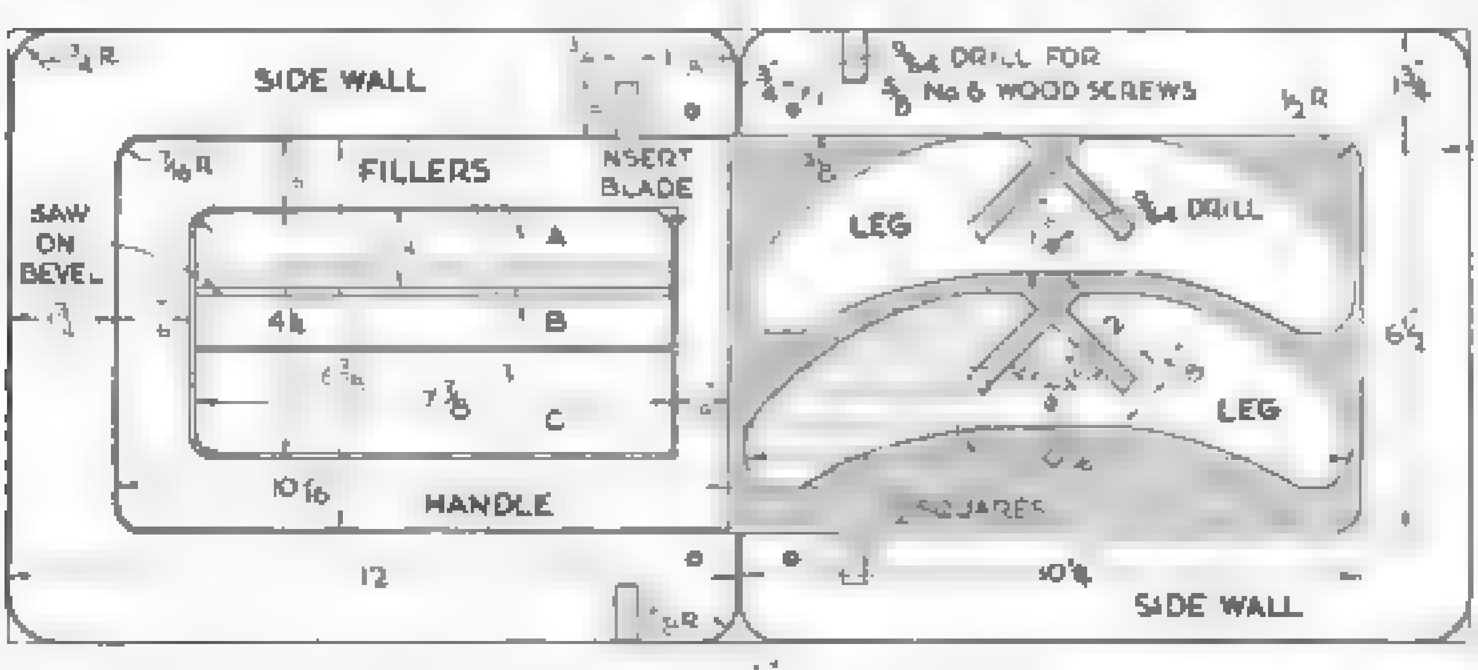
DESIGNED BY ERNEST R. DEWALT

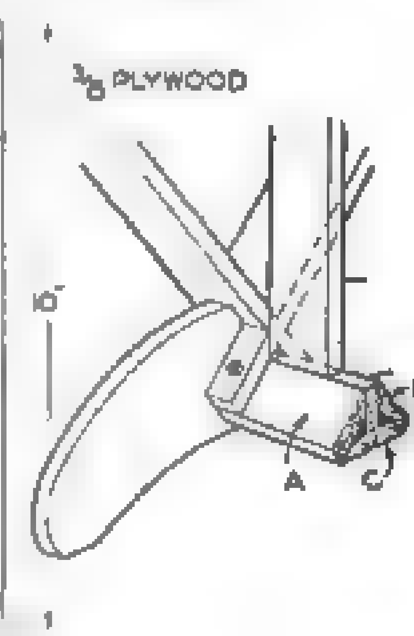
MAGAZINES—especially those cherished back issues we cannot bring ourselves to throw away—are a perennial problem in almost every household, but one that a few racks and shelves will go far toward solving. Here are two material-conserving designs.

Magazine rack. The sum total of materials needed for this sturdy "open-walled" project consists of a 10" by 24¼" piece of ⅝" plywood, six ⅝" No. 6 wood screws, and a little glue. Lay out all the parts on the single sheet of plywood as shown in the drawing, being sure to allow space as indicated for the passage of a band-saw or jig-saw blade. Note how the half laps are cut—one on the inside and one on the outside edge of each of the sidewalls.

Draw in one leg pattern by means of ½" squares, and transfer it to the plywood sheet for the two legs required. As a further assurance that they will match exactly, espe-

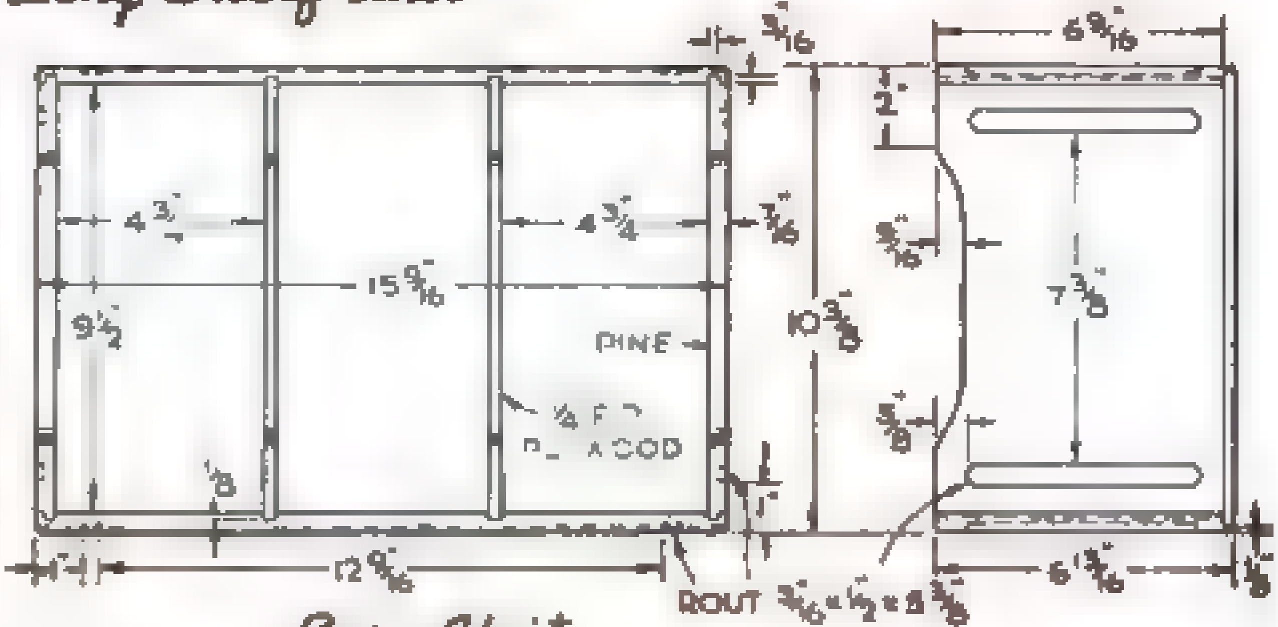
Lay out all parts of the rack on one sheet of plywood, as below. At right, detail of construction



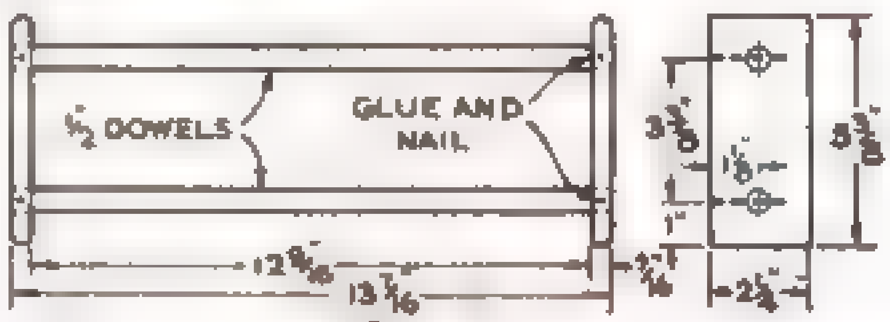


Long Shelf Unit

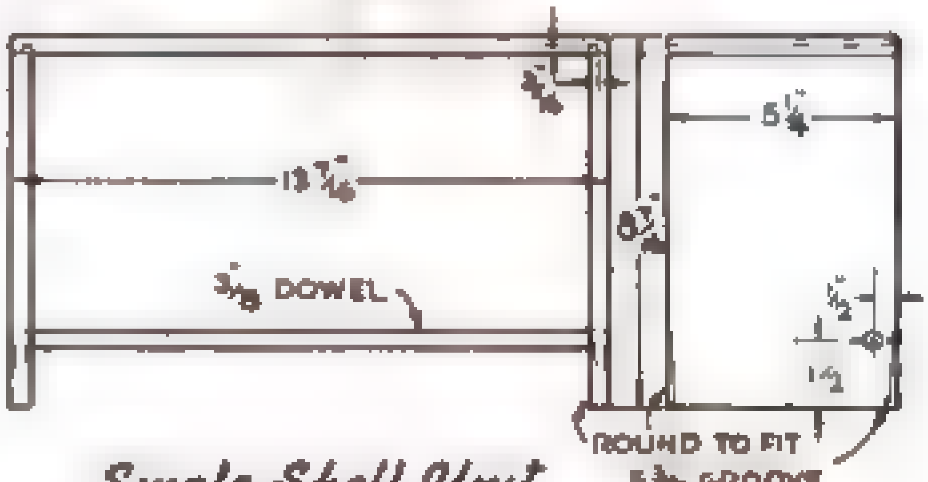
Four separate units are used in any number or combination for neat magazine shelves. The basic unit just at the right is a boxlike section with three compartments. It is recessed on top, bottom, and sides to be fitted easily with the base shown below it or the single-shelf unit at the bottom. The long shelves at the top are used with two or more of these basic units



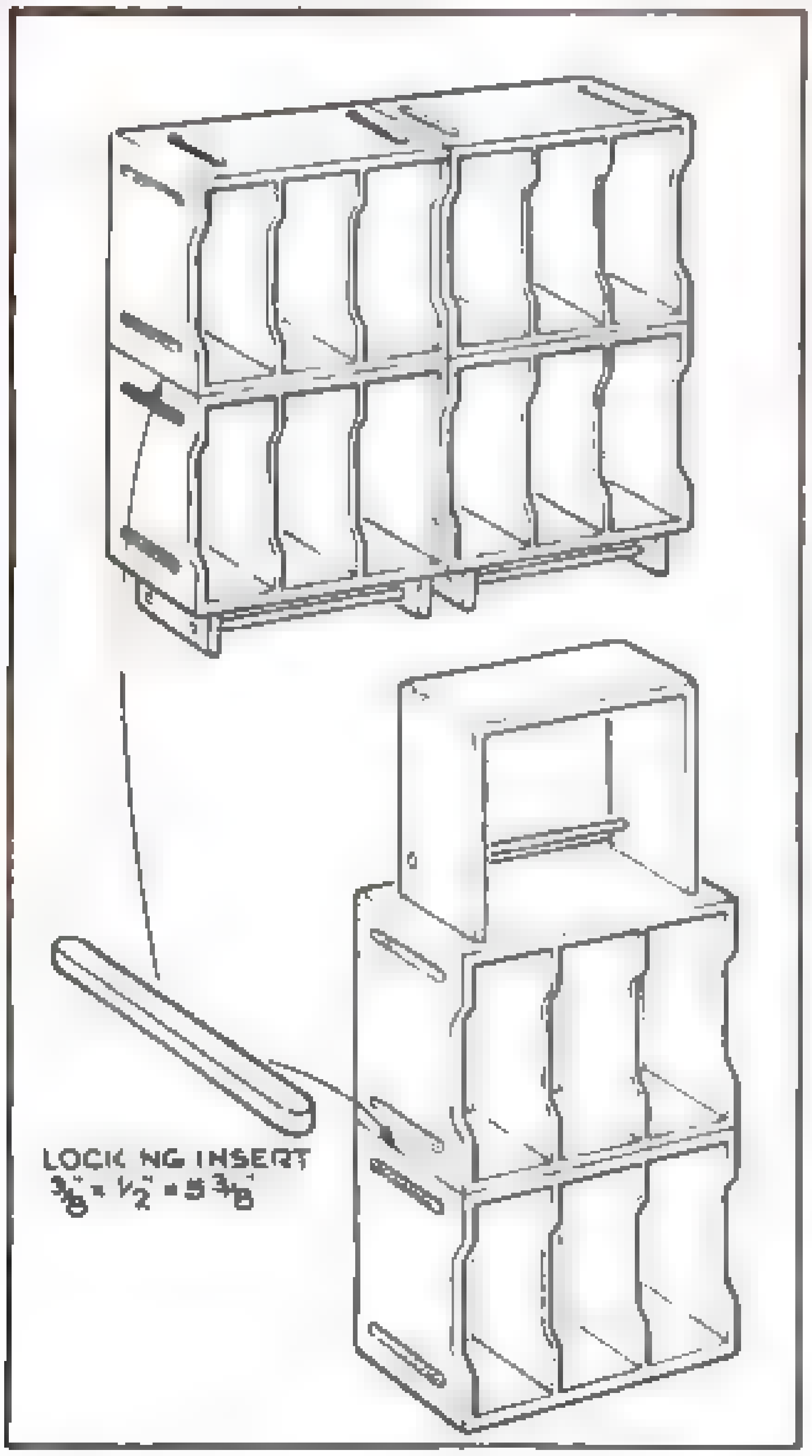
Basic Unit



Base



Single Shelf Unit



Basic shelf units may be attached to each other with the aid of locking inserts (above) which fit in recesses in adjacent faces and prevent sliding

cially at the notched section, it is advisable to saw the two legs roughly to shape around the outside, tack them together, and cut out and notch both at one time. This is necessary for proper alignment.

In laying out the filler pieces, note that one edge of *A* and *B* 's beveled and the saw cut so made. Piece *C*, of course, is sawed first with vertical sides, and then beveled as in the detail at the right of the drawing, which shows all three glued up around the lower part of the handle. These filler pieces, 7 3/8" long, extend 3/4" beyond the handle piece on each side and should be flush at the ends for a flat bearing against the inner surfaces of the legs.

Glue together the half-lapped members,

slip the legs into place, and fasten with glue and screws to the handle as indicated in the detail drawing. One screw passes through the leg into the horizontal filler piece *C* on each side.

Round off all edges with sandpaper. An attractive color finish that shows the grain of the wood is obtained by applying oil color thinned with oil and turpentine. Wipe off any excess and, when it is dry, wax and polish the piece. Approximate time, 4 hours.

Unit shelves. The various parts of these shelves can be assembled in many ways to suit the space available and the taste of the builder. One of the boxlike main units will accommodate 36 issues of POPULAR SCIENCE MONTHLY. Larger magazines and books may be kept in the other shelf units.

The basic units are made of 7/16" pine with rabbet-and-dado joints at the corners and 1/4" plywood backs and partitions. Note that the backs are rabbeted into the tops and bottoms, but extend across the sides to form simple butt joints. The front edges of all sides and sectional divisions are cut out to facilitate handling magazines when the compartments are full.

Finish all edges and joints on each piece, then rout out two 3/16" by 1/2" by 5 3/8" recesses in each side, top, and bottom. Accurately located, these recesses will make possible the use of any number of basic units in a variety of assemblies.

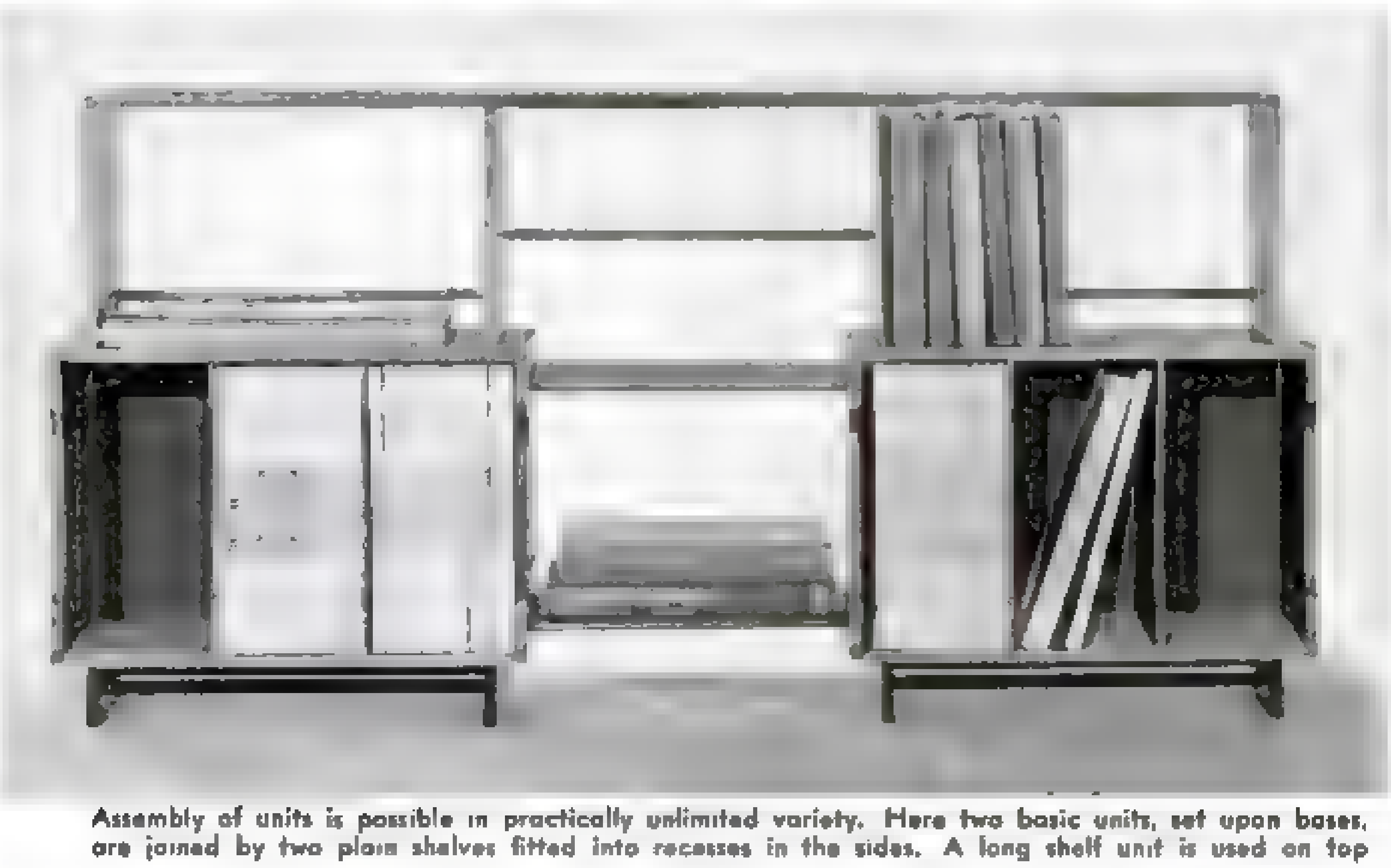
Bases are made from 7/16" stock and 1/2" dowels. Round off the vertical edges of the endpieces so that these will fit into the recesses in the main units. Also to accomplish this, all dimensions must be carefully adhered to.

Short and long shelf units, and also single shelves, are made up as shown in the drawings to suit individual needs. Two designs are offered, but original ones may be substituted in some cases if it is borne in mind that the dimensions given must be followed exactly where these shelves fit into the recesses in the main units. For this purpose, the ends of all are shaped in the same manner as the vertical edges of the endpieces of the bases.

The photograph reproduced below shows one possible assembly, combining two basic units and two bases joined by two single shelves, the ends of which fit into the recesses in the adjacent sides. A long shelf unit is used here over the top of all.

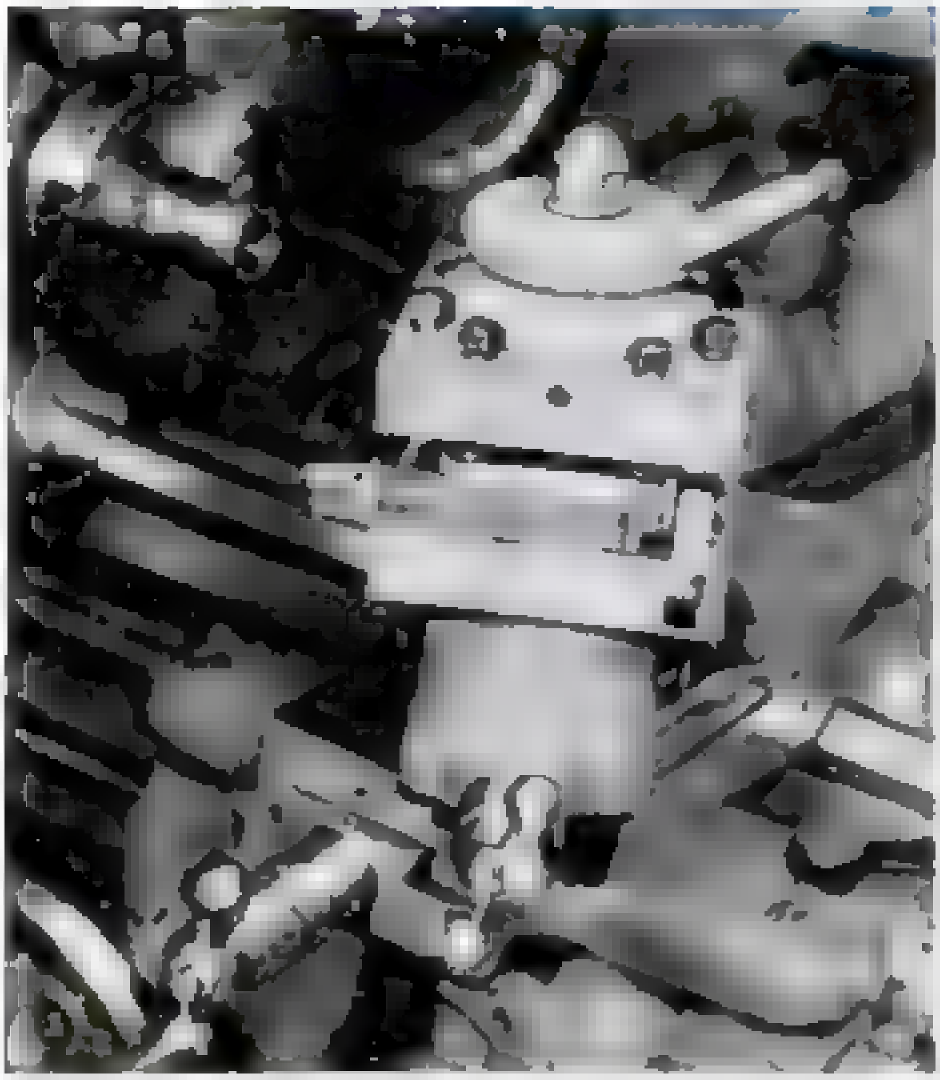
Where two or more main units are to be stacked, one on top of the other or side by side, they are locked together with pieces of plain 3/8" by 1/2" by 5 3/8" stock placed in adjacent recesses.

Any desired finish may be used to adapt the units to individual decorating schemes. A dull black is suitable for the interior of the basic units. Burnt umber thinned with oil and turpentine may be wiped into all other surfaces for an interesting two-tone effect. Wax well when dry. Approximate time: one basic unit and base, 6 hours; one short and one long shelf unit and two single shelves, 6 hours.



Assembly of units is possible in practically unlimited variety. Here two basic units, set upon bases, are joined by two plain shelves fitted into recesses in the sides. A long shelf unit is used on top

Lathe Tool-Post



Mounted on the lathe, this turret will hold four tools and speed consecutive operations on production work

By C. W. TALBOT

FOUR lathe tools can be mounted in this shopmade turret attachment, which brings one after the other of them into exact working position as required, thus greatly speeding up consecutive operations where a large number of identical pieces must be made. By using a stop on the cross slide, and setting the tools in the turret so that they cut only as far as desired, the operator can turn piece after piece to identical size, cut shoulders and threads to a specified depth, and so forth.

The original was made for a 9" lathe from three simple castings. These should be of steel if possible, although cast iron will serve. Where castings cannot be obtained, the parts can be made of cold-rolled steel, but this will involve a great deal of extra turning. The body *A* might be built up of three pieces of ¾" steel plate, bolted together on all four sides; however, a casting should be used for this part if at all possible.

To make the pattern, dowel together two 1⅛" by 2½" by 3¾" pieces of wood to form a block 2¼" by 3¾" by 3¾". For lathes larger than 9", these and all other dimensions should, of course, be increased to suit. Clamp the block and bore a ¾" hole through the 2½" thickness where the diagonals cross. Glue in the two halves of a ¾" diameter split turning, letting the ends project about ⅝" to form a core print. Cut the tool slots slightly undersize and, with rasp and sandpaper, taper the pattern back on both sides from the parting line to provide the necessary draft for drawing it from the sand.

Simple shouldered turnings comprise the patterns for *B* and *D*, the latter casting being shaped on the lathe to save the trouble of making a split pattern for it.

Mount the body casting *A* in a four-jaw chuck to face off the bottom; then reverse to face off the top. The casting is chucked at right angles for facing the four sides square with the top and bottom. As there is considerable overhang, caution should be exercised in both chucking and the actual turning. Use a tool bit ground for cast iron, if the casting is of that material, with correct clearance and rake angles.

Again chucked bottom out and accurately centered by means of diagonals, the casting is centerdrilled, bored to just under 1", and reamed accurately to size. One of the illustrations shows this step of the work completed and the stepped recess being turned for the post *B*. Rechuck with the top out to turn the opposite recess for the raising nut *D*.

The body casting is bolted to the compound rest so that a ½" milling cutter mounted in the spindle can be used for milling the tool slots to size. Block it up first to mill out the bottoms of all four slots; remount it on a lower block to permit milling the tops of the slots. Use very light cuts only. This operation can, of course, be done more quickly on a shaper or milling machine if one is available.

The column casting *B* is chucked, centerdrilled for tailstock support, and rough-turned. A 31/64" hole is drilled through it. This is reamed to ½", and the casting is then mounted on a mandrel and accurately turned to size. Make the lower flange .003" thicker than the depth of the corresponding recess in the body, so that the latter will bear on it and not on the compound rest. Finally, cut the threads as specified in the drawing.

A shoulder is turned on the locking and raising nut *D* to a running fit in the top recess. A ⅛" wide 90-deg. V-shaped groove is

Turret

turned in this part to receive the points of the four headless setscrews that raise the turret body when the nut is rotated. The nut is bored and internal threads are cut at the same chucking to fit those on the column. The piece can then be reversed in the chuck and turned to the shape shown in the drawing. A spot facing is made, drilled, and tapped for the handle, which is turned to fit.

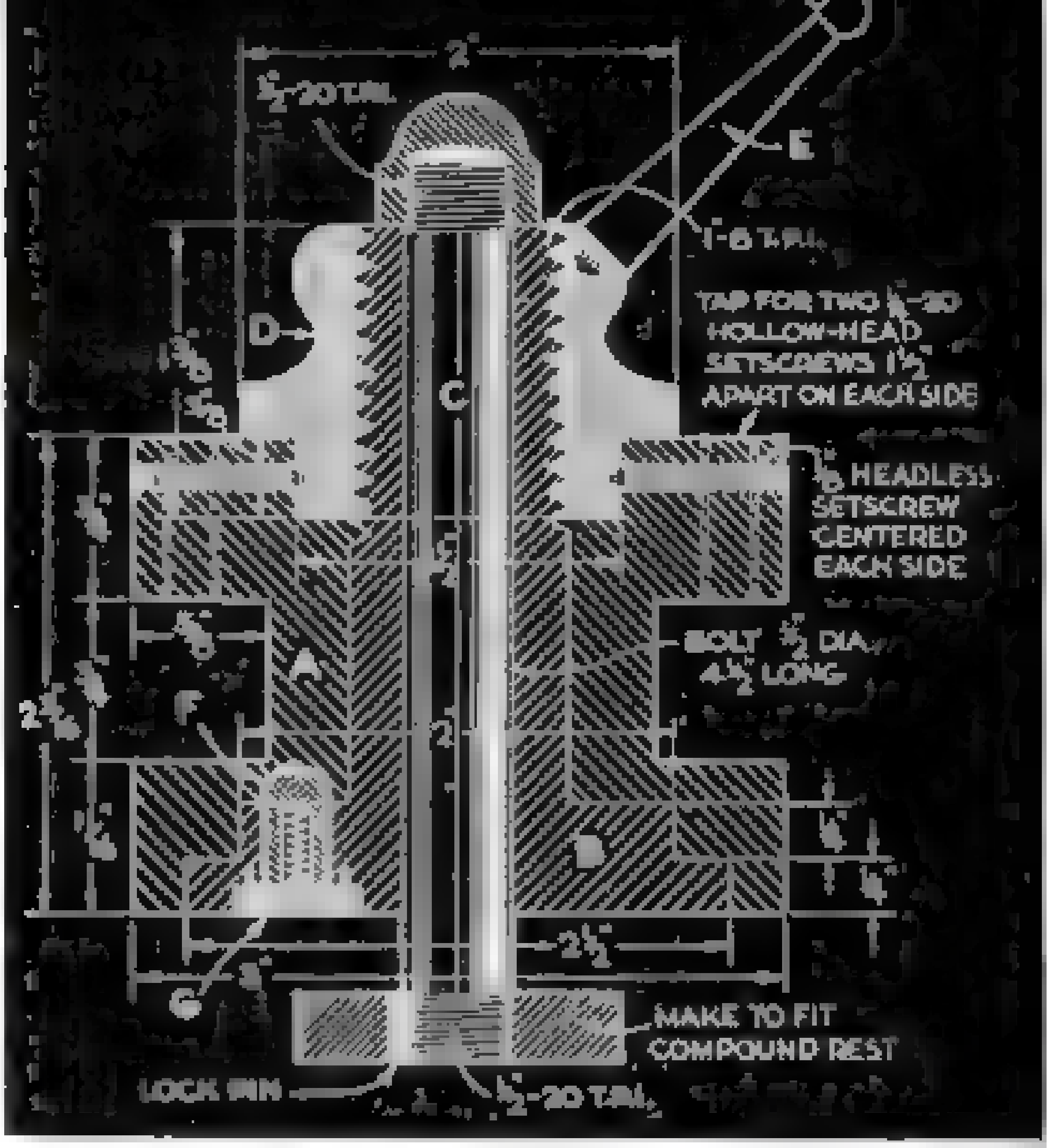
The bolt *C* is turned from ½" cold-rolled steel, threaded at both ends, and provided with a keyed plate that fits the slot of the compound rest. An acorn clamping nut may be used at the other end; it must be small enough to permit the locking nut *D* to rise unobstructed.

Holes may now be drilled and tapped in the body for the eight hollow-head setscrews that hold the tools in place, and also for the four pin screws that retain the locking nut *D*. The latter is inserted and the retaining pins screwed in.

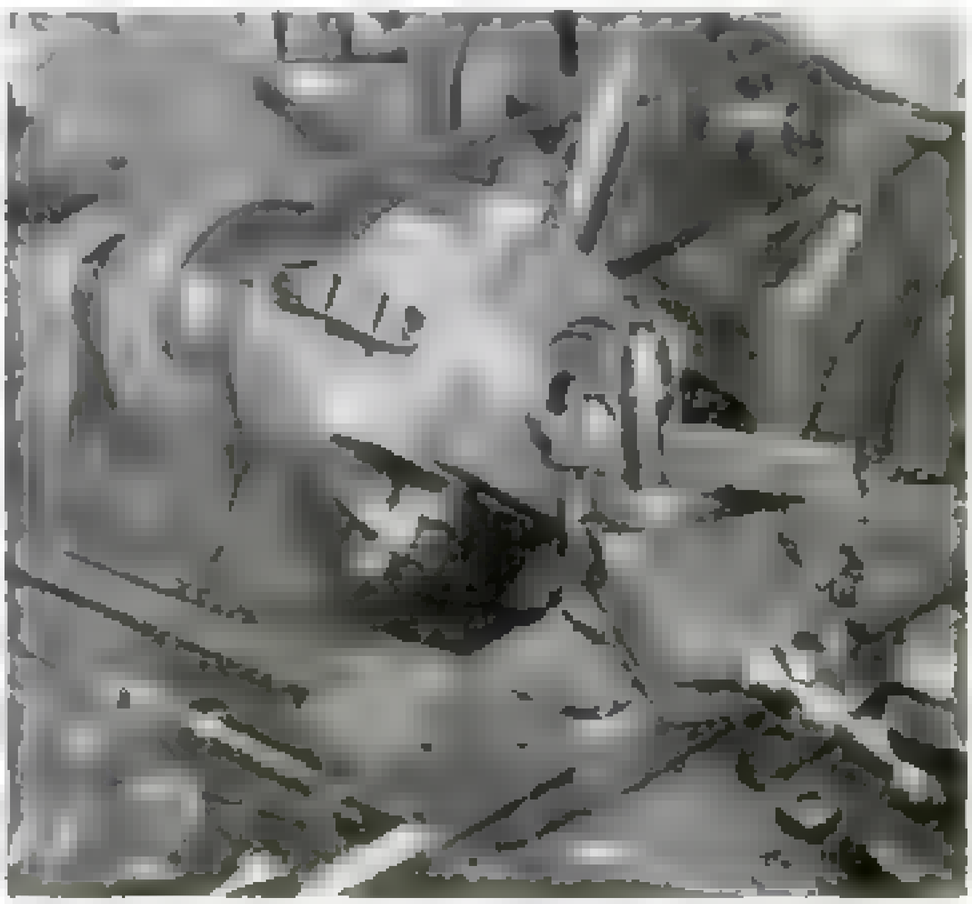
Drill a very small hole through the flange of the column *B* in the position of the indexing pin. Insert the column in the body with the hole on a diagonal and drill through into *A*. Push a phonograph needle into the column flange so that it projects 1/64" from the shoulder and enters the hole in *A*.

Clamp the turret on the compound rest loosely. Move the carriage up against the faceplate of the lathe so that one side of the turret bears against the surface evenly; then clamp the column tightly in position.

Back off the carriage, lift the body off the column flange, rotate it one quarter turn, and run it back against the faceplate again.



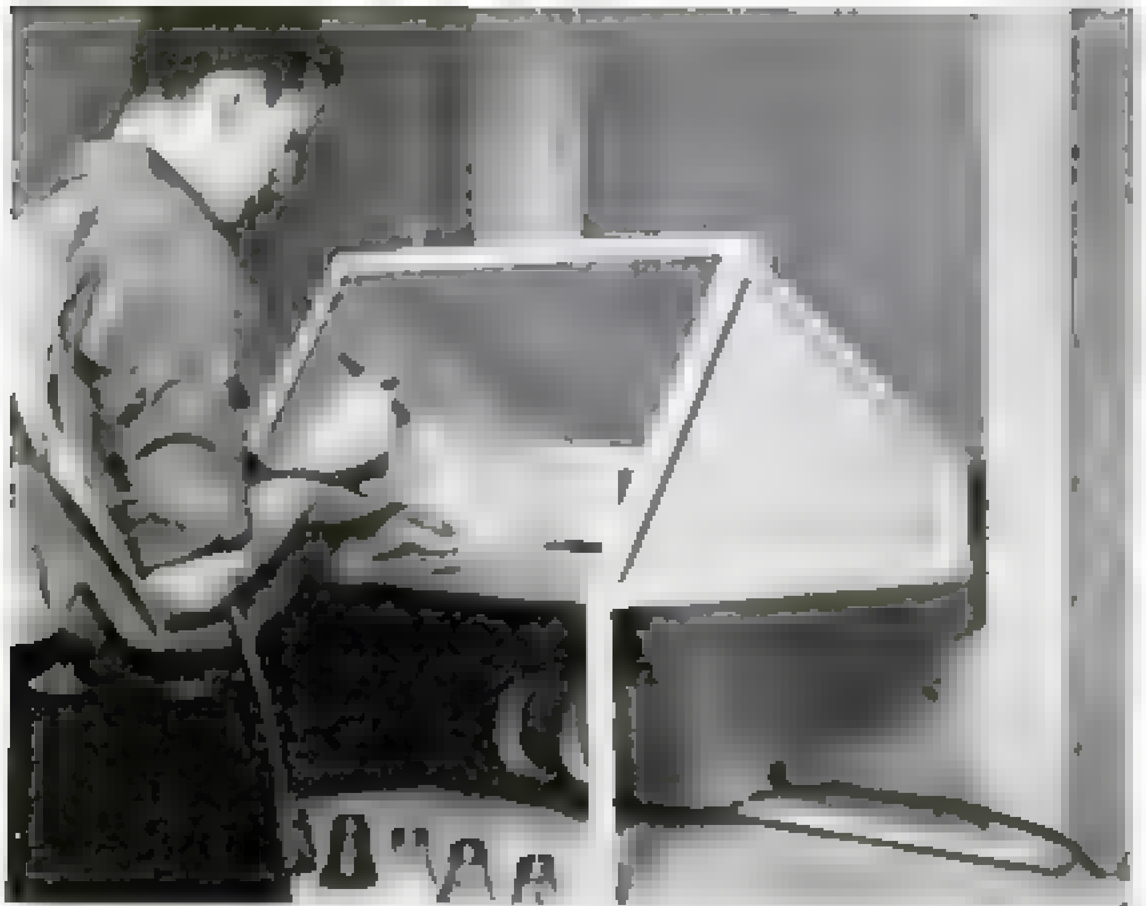
Above is a cross-section drawing of a tool-post turret designed for a 9" lathe. Below, an operation in making the body—turning the stepped recess in the bottom

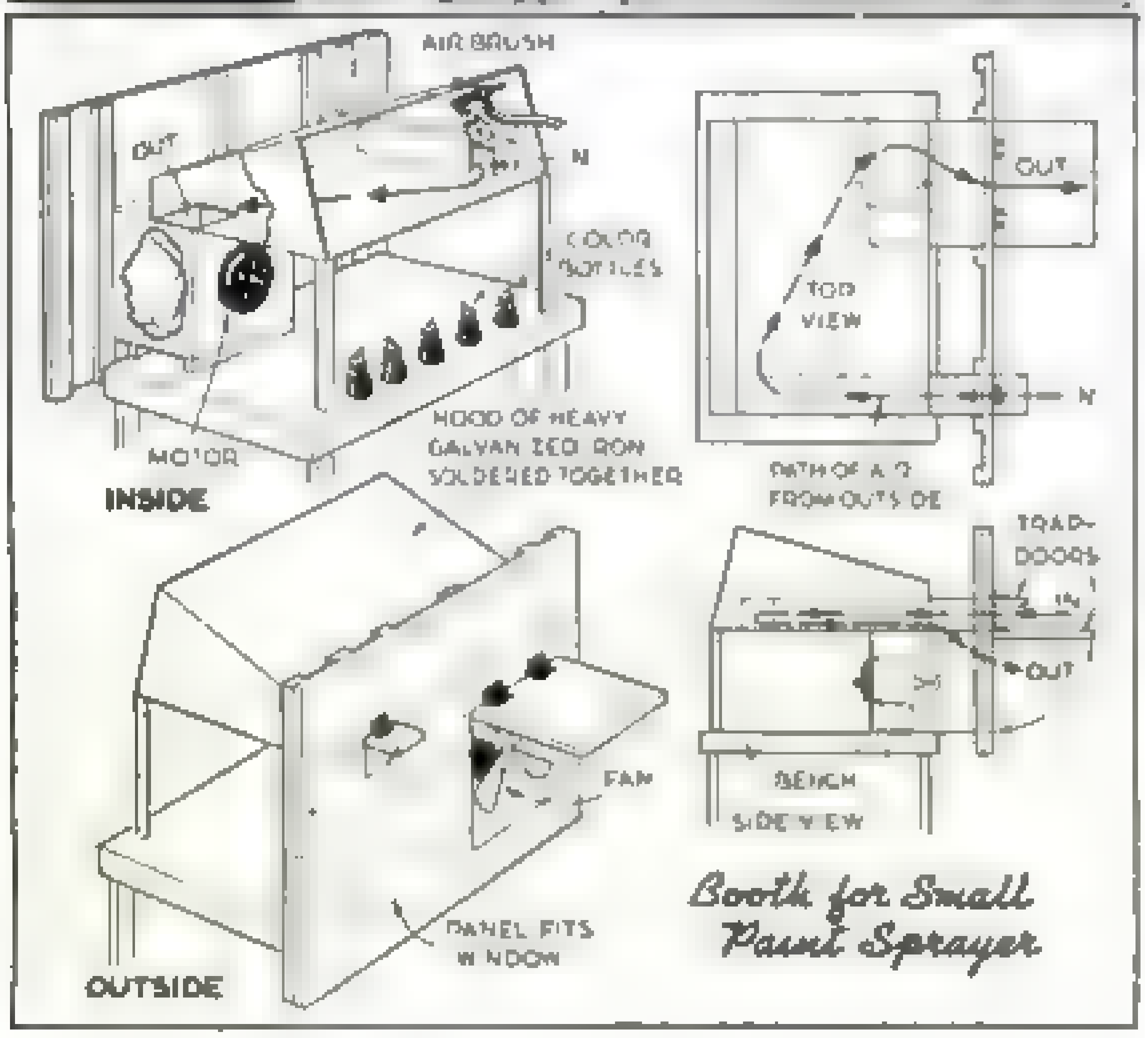


Now drop the head down on the needle to mark the second indexing hole. Repeat on the other two sides.

Drill on the marks so obtained to a close fit for the indexing pin *F*. The pilot hole in the column flange is also drilled for this pin, and counterbored for retaining plug *G*, or else drilled from the top not quite through. The pin itself is hollowed to accommodate a small spring as shown in the drawing. Make the indexing pin short enough to allow the spring to come into play.

Window Booth Exhausts Fumes from Small Paint Sprayer





Booth for Small Paint Sprayer

FOR paint-spraying novelties and small parts, the window booth illustrated has the advantage of providing a steady stream of air from the outside, into which the spraying is done. The temperature of the room is not affected, yet no trace of fumes or unpleasant odor remains.

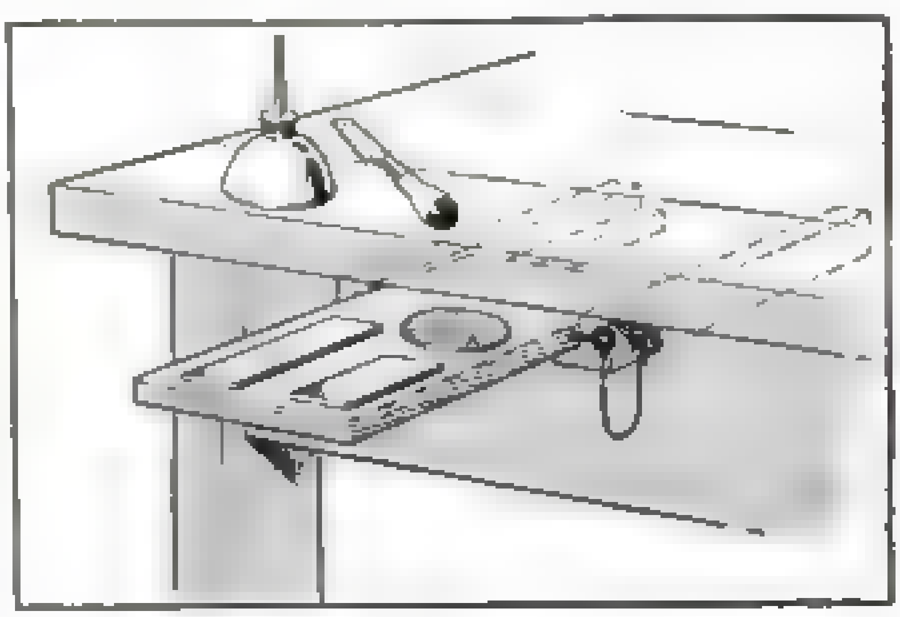
The size of the booth depends upon the dimensions of the window. If desired, a full-size model of the hood may be constructed from cardboard to find the correct measurement for the various parts, which are then cut from heavy galvanized iron and soldered together.

A wooden panel of ¾" stock is sawed to size to fit the window opening, and the panel is then cut as indicated in the drawings to receive the air inlet and outlet. Trapdoors are hinged on the outside of the panel for regulating the flow of air.

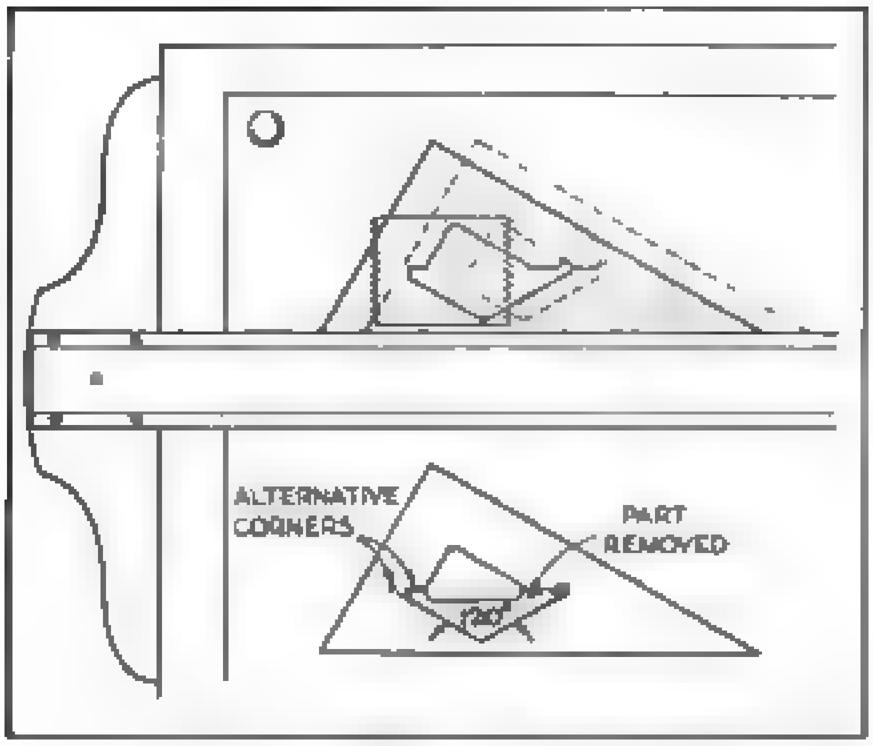
The hood is mounted on a bench as shown, and the motor, with fan attached, is fastened inside the air outlet, exhausting outward. The rear of the motor projects through the back of the air-outlet box for cooling.

It will be found that the room temperature can be kept constant when the fan is running by adjusting the size of the air inlet and outlet holes inside the hood. Remember to spray directly into the air stream.—JOHN DOYLE.

Special Bench Drawer Keeps Sharpening Stones Handy



A GOOD way to keep sharpening stones handy, yet out of the way and free from dirt when not in use, is to fit each one into a board as shown, and fasten runners under the top of the workbench so the board will slide in like a drawer. Recess for each stone so that only about ⅛" protrudes. A heavy pin in the edge of the drawer will keep it from sliding back while tools are being sharpened.—C. E. LIMBERG.



Guide Lines Cut in Triangle Useful in Drawing Threads

AN ANGLE of 120 deg. cut as shown in the hypotenuse of the opening in a draftsman's 60-deg. triangle will provide a handy guide for drawing threads. The angle of both edges should be at 60 deg. from the vertical. The triangle can be slid from side to side for continuous drawing, saving the time of turning it over.—HENRY DROUYN.

• • •

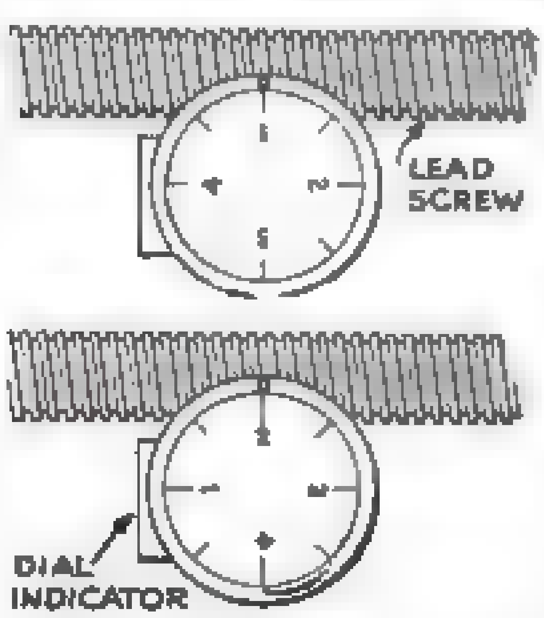
A SMALL horseshoe magnet fastened to an electric scroll-saw stand will remove broken blade tips, which, on certain types of saws, usually drop into the hollow shank of the lower chuck. This saves the trouble of removing the chuck and shaking it to get out the piece.—ROGER M. WOODBURY.

Simple Jig for Dusting Grit Out of Spring-Type Collet

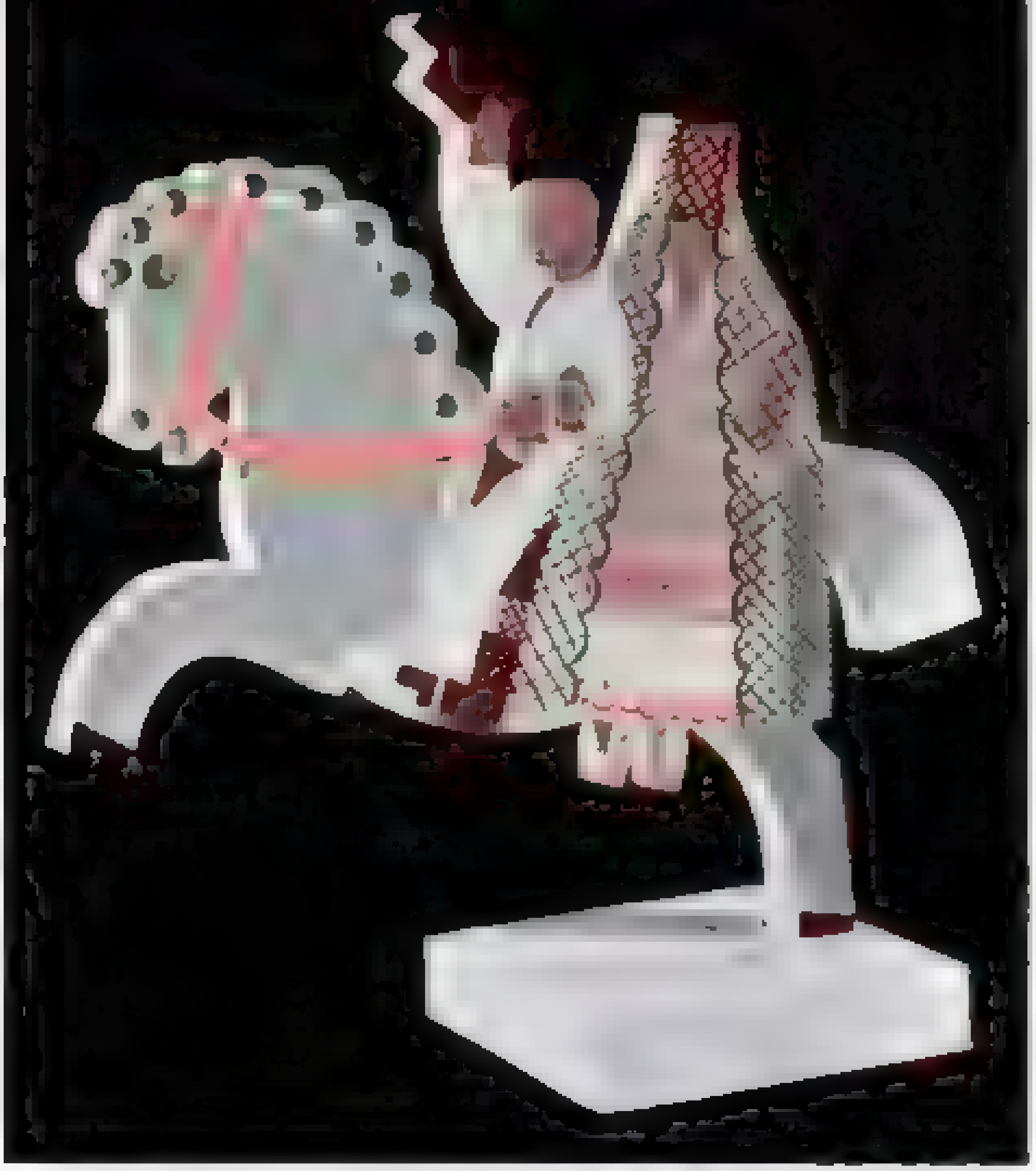
DIRT and grit collecting in the slots of a spring-type collet may interfere with the closing of the jaws if not cleaned out. The simple jig shown below will clear all three slots with a single stroke. It consists of a metal ring to which is attached a three-way spider of fine steel wires fastened 120 deg. apart to correspond with the angular separation of the collet slots. To be suitable for collets having very small holes, the wires are attached in the center of the ring by butt welding with a small carbon-arc outfit, a method which leaves no appreciable bulge.—W. C. WILHITE.

THREAD DIAL INDICATOR [*LATHE WORK*]

The thread dial indicator saves much time in cutting threads because it allows the operator to unclamp the split nut from the lead screw when the end of the thread chip is reached. The carriage can then be returned quickly by hand to the starting point for the next cut. For all even-numbered threads, close the half nuts on any line on the dial. For all odd-numbered threads, close the half nuts at any numbered line on the dial. For threads of a pitch involving one half of a thread per inch, engage the feed nut at any odd-numbered line. Bear in mind that each interval on the dial represents ½" of carriage travel. That between two numbered lines, shown in the two positions of the dial at the left, represents 1" of carriage travel such as is used for cutting odd-numbered threads. For all threads involving one half of a thread per inch such as 11½, the dial should indicate 2" of carriage travel, or, in the example given, 23 threads on the work, before the half nuts are closed.

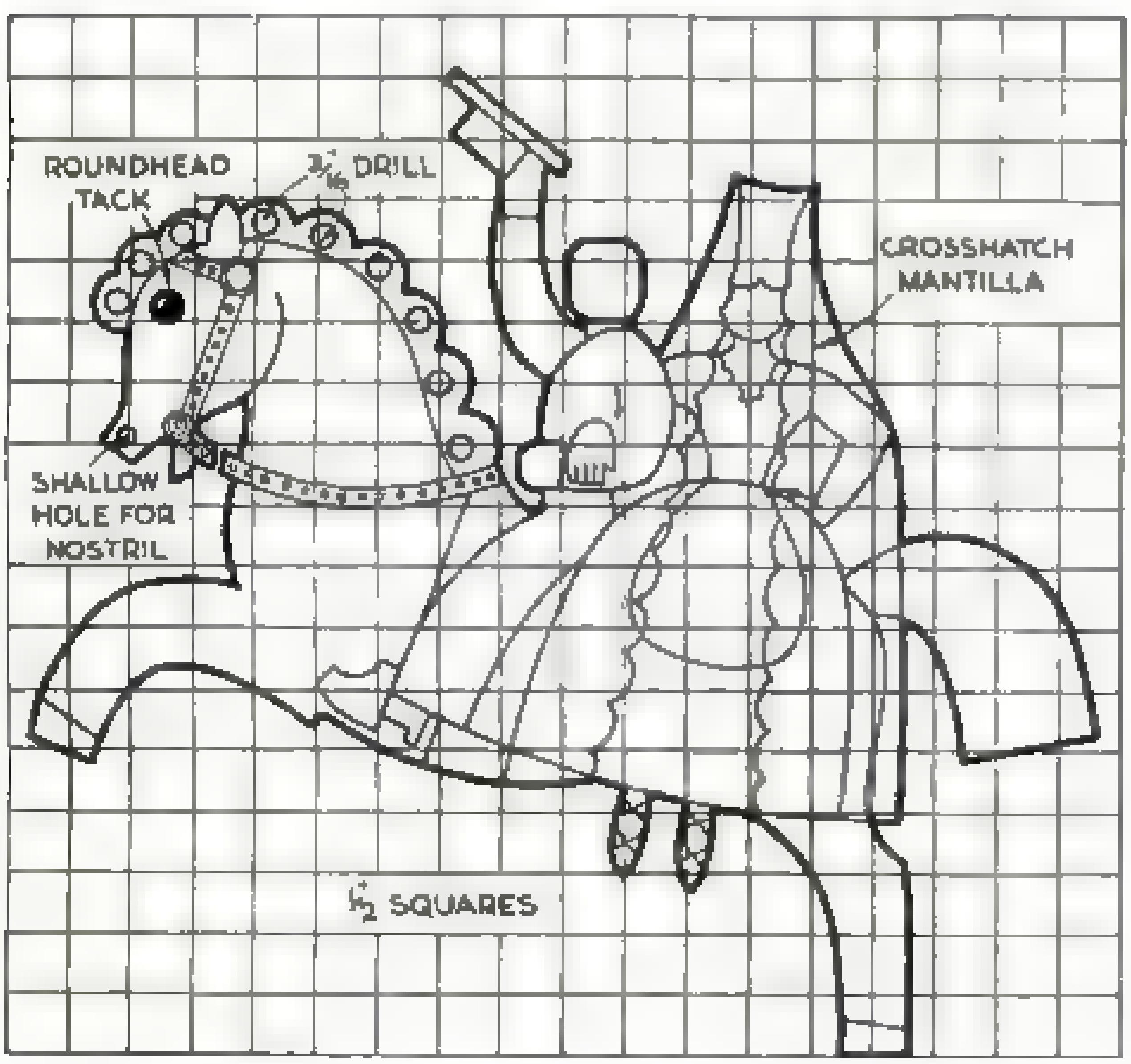


POPULAR SCIENCE MONTHLY SHOP DATA



Pampas Wedding

A JIGSAWED ORNAMENT IN THE SOUTH AMERICAN WAY



By JUAN OLIVER

THE fiesta spirit of South American weddings is expressed in this unique piece of jigsawed wood "sculpture." Although especially effective when displayed with the illuminated stage or shadow box on the facing page, it can be placed on a mantel or wall shelf or in a bookcase. The piece illustrated was made entirely on a band saw. However, the proficient craftsman may wish to elaborate it by using hardwood and carving certain portions in semirelief, rounding the edges, and so forth.

Draw 1/2" squares on an 8 1/2" by 9" piece of 1/8" plywood and trace the pattern on these by following it on the squares in the drawing. Saw to the outside profile first; then run the blade through the rein under the chin of the horse to cut out the small triangular part. The rein is cut short just ahead of the rider's hand to eliminate an inside cut at this point.

Drill nine 3/16" holes in the mane, and a shallow one for the nostril. Sand smooth all over; then mount on a wooden base by means of a single wood screw in the horse's hind leg.

A filler coat of thin shellac may be applied if japan or oil colors are used for finishing. The original was painted in black, white, red, and gray, but bright colors might be used in matching some decorative schemes.

Adequate lighting shows off any piece of craftwork to better advantage. Side lighting on carvings, for example, shows in three-dimensional relief the many planes and angles, and provides interesting high lights. The illuminated shadow box shown here affords such lighting in an ideal form, independent of general room illumination.

Although designed to be set upon a mantel or shelf, it can be let into a wall niche, a bookcase, or even an unwanted doorway. In the latter case shelves may be built around the box, or it may be set into a wall-board panel fastened to the doorway molding to leave space for the depth of the box behind

Cut the plywood front slightly longer than specified, and saw in it the centered 9" by 11¼" opening. Glue and nail up the top, bottom, front, and sides with simple butt joints, using ½" by ½" reinforcing cleats at the front corners. Similar cleats behind form a rabbet for the back

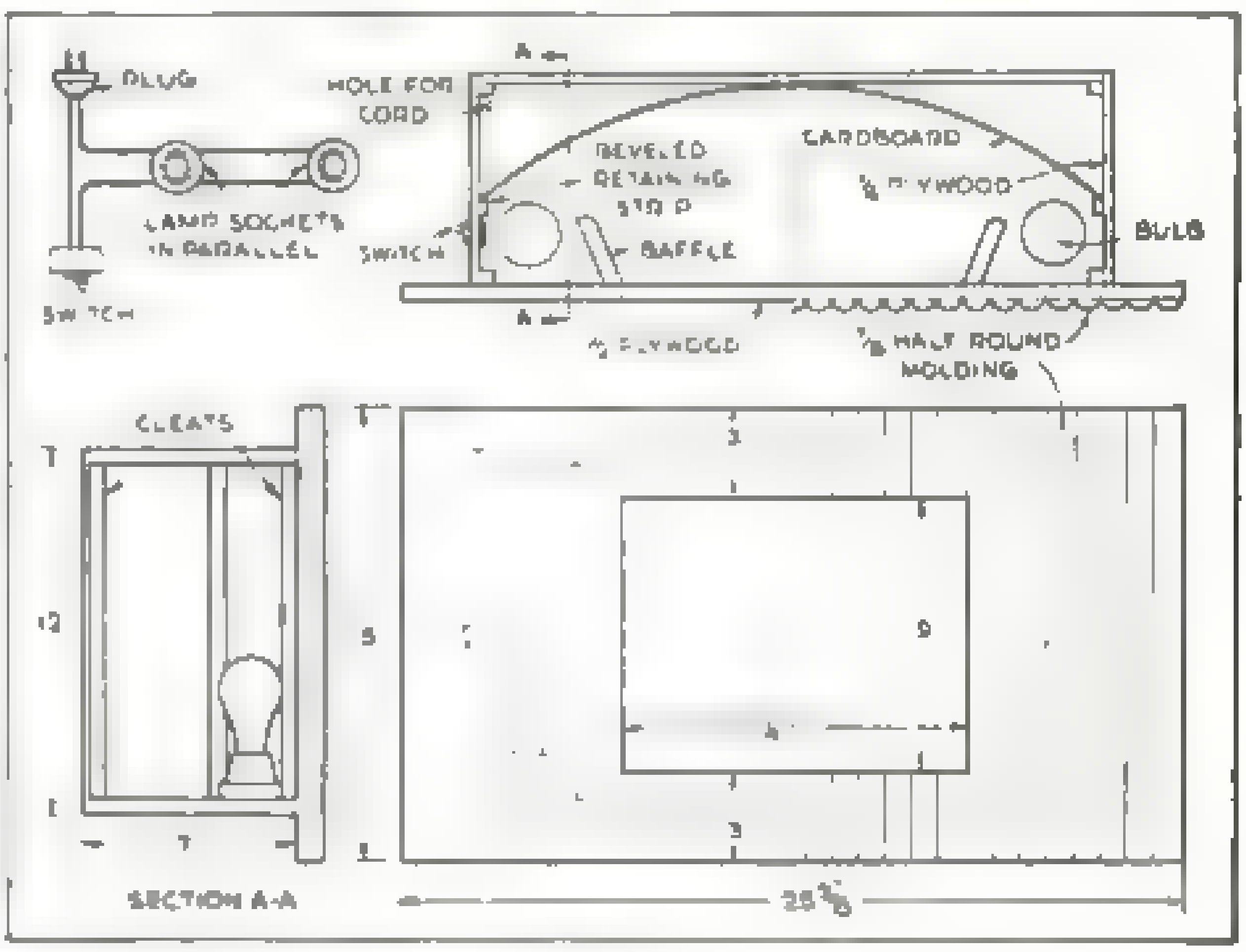
Mount the porcelain lamp sockets and the switch and wire these before fitting the light baffles in place. For wall mounting, in which only the front and inside of the box would be accessible, mount the switch on the bottom or on the back of a baffle so that it can be operated through the front opening

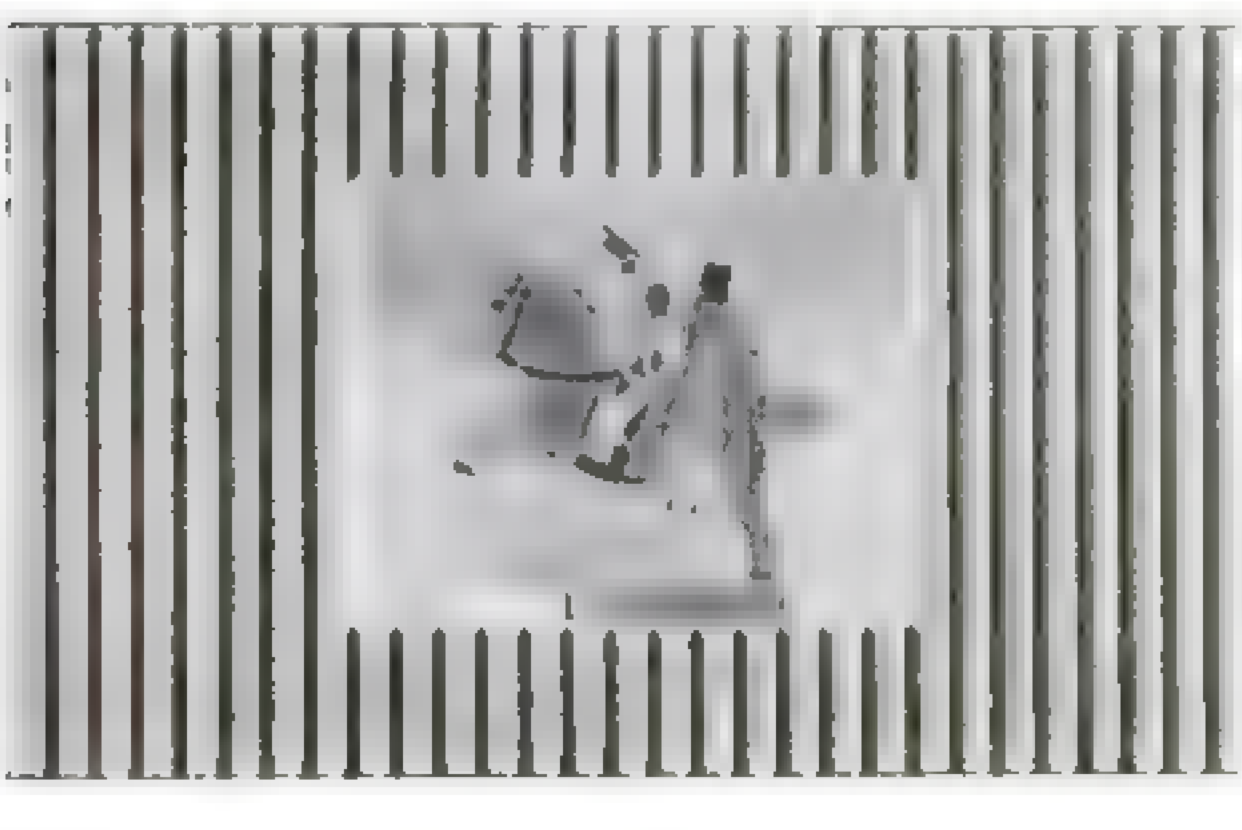
Nail in two beveled retaining strips to hold a cardboard backdrop in place. Drill and countersink the ¼" plywood back so that it can be screwed to the cleats.

Commercial half-round molding is cut to length and glued to the front. Start with the two center pieces above and below the opening, working out toward both ends. Be sure to keep the molding perpendicular to the top and bottom edges. Finally, trim the ends of the plywood flush with the last strips.

After sanding thoroughly, apply a priming coat of shellac or thinned floor varnish. Flat white or gray wall paint is excellent for a neutral finish, but pastel colors may be used to match woodwork or walls if desired, and in some cases even black might be employed to advantage. The cardboard backdrop used should be of a color appropriate to the object being displayed.

If larger than 25-watt lamps are used, holes should be drilled in the sides, top, or bottom to provide air circulation for cooling. With small bulbs this is unnecessary, but in any case watch carefully when the lamps are on for any signs of overheating.





Used with the jigsawed wood "sculpture," this lighted shadow box is an effective stage. It is made of plywood, finished with half-round molding, has a colored cardboard backdrop and two hidden light bulbs

More Tin-Plate

Fig. 1. Watering pots for many garden needs, indoors and out. These were made from tin cans

Watering Pots, Ash Tray,

SHORTAGES of conventional materials didn't stop the craftworkers who made the projects illustrated on this and the facing page for a recent contest conducted by POPULAR SCIENCE MONTHLY. They turned tin plate from cans and also entire cans into attractive, useful articles of their own design, using only simple hand tools.

WATERING CANS. You can use your imagination freely in making all sorts of garden sprinklers and indoor watering cans. The one at the left in Fig. 1 is a tall fruit-juice can 4¼" in diameter, to which is soldered a top hammered into a dome. A 2" hole cut out of this at the back permits filling. The handle, spout, and brace, bent from scrap copper tubing, are soldered on.

The middle container, a pouring measure equally handy for watering potted plants, has a spout and hood bent from tin plate. Paper patterns aid in laying these out. The body is a 3-lb. shortening can. Both edges of a 1" wide strip are folded in for a handle, which is soldered on at the seam.

A decorative note is added to any indoor garden by the picturesque little watering pot in the foreground. The body is an asparagus can, and the tapered spout is stock from another, rolled and soldered. A flat piece is soldered across half the top.

The head, neck, and spout of a discarded sprinkling can, fitted to a can 6" in diameter, make the garden waterer at the right. The edge of the hood is folded back, as are both edges of the two-part handle.

One undercoat and one coat of four-hour enamel are a sufficient finish. Charming two-color effects are easy to obtain. Decalcomania transfers may be added.

ASH TRAY. One that needn't be emptied every few minutes yet always looks presentable is shown in Fig. 2. The body is a coffee can with the center of the lid cut out and the sloping top of a tobacco tin soldered to it. This latter has a center hole 1½" in diameter. A tube rolled from a piece of tin plate is soldered to the bottom of the can, and another one, small enough to telescope freely into the first, to a domed bottom neatly cut from a beverage can. To the top of this is soldered a coffee-can key. The spring is from an electric-iron cord.

NAIL AND BRAD TRAY. The handy man will want this useful accessory (Fig. 3) for himself. Three coffee cans and four halves of soup cans are grouped on a piece of ⅜" plywood sawed to shape from a pencilled outline. The cans are coated with aluminum paint inside and out, and fastened with

Craftwork

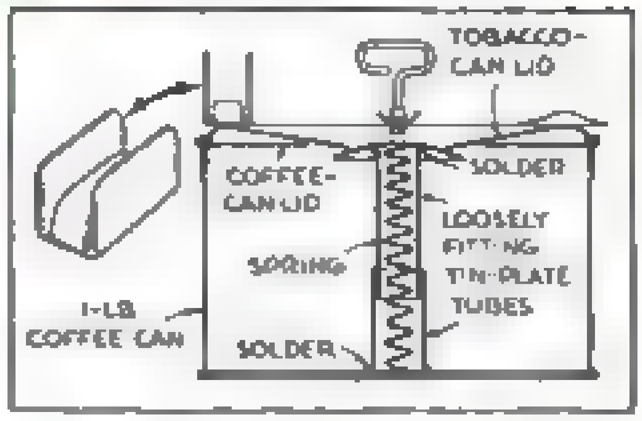


Fig. 2. This handsome ash tray, large enough to save frequent emptying, started life as a coffee can. Its clever spring center makes it safe, too—even if it is upset, ashes can't spill

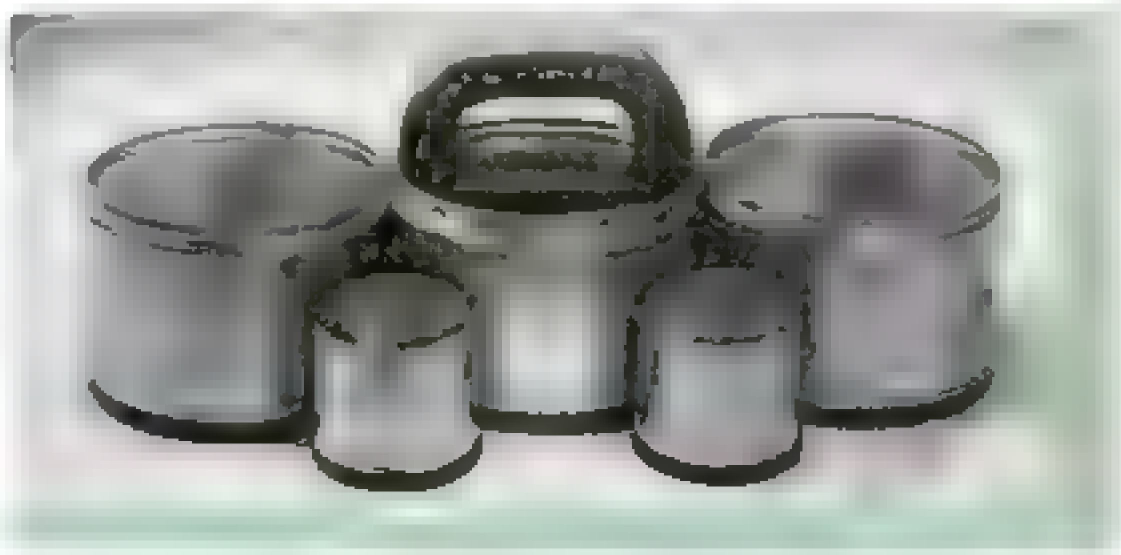


Fig. 3. Coffee cans and halves of soup cans make this nail and brad tray for the handy man. They are grouped on plywood, which is sawed to shape from an outline marked with pencil. The base may be stained and varnished before cans are attached with wood screws

Nail Carrier, and Cookie Cutters

small wood screws. The handle is a jig-sawed piece reaching to the bottom of the middle can and dividing it into two parts. It is held by two countersunk wood screws through the bottom, and small nails near the top edge of the middle can.

COOKIE CUTTER. Cookies can be made in any shape if the home workshop supplies cutters such as in Fig. 4. The shape is sawed from a thin piece of wood and nailed to a board. Then tin-can stock cut into ⅜" wide strips is bent around the form, a broad screw driver forcing it into sharp corners. If one strip is not long enough, a second is soldered on, and the ends are finally soldered together. Crosspieces are soldered at several points to help retain the shape, and a handle soldered in place. The cutter is boiled a short time in soda and water to remove traces of flux. Figure 4 shows a form (at left), a cutter, and a cookie made with it.

Fig. 4. Cookie cutters are shaped from strips bent around wood forms

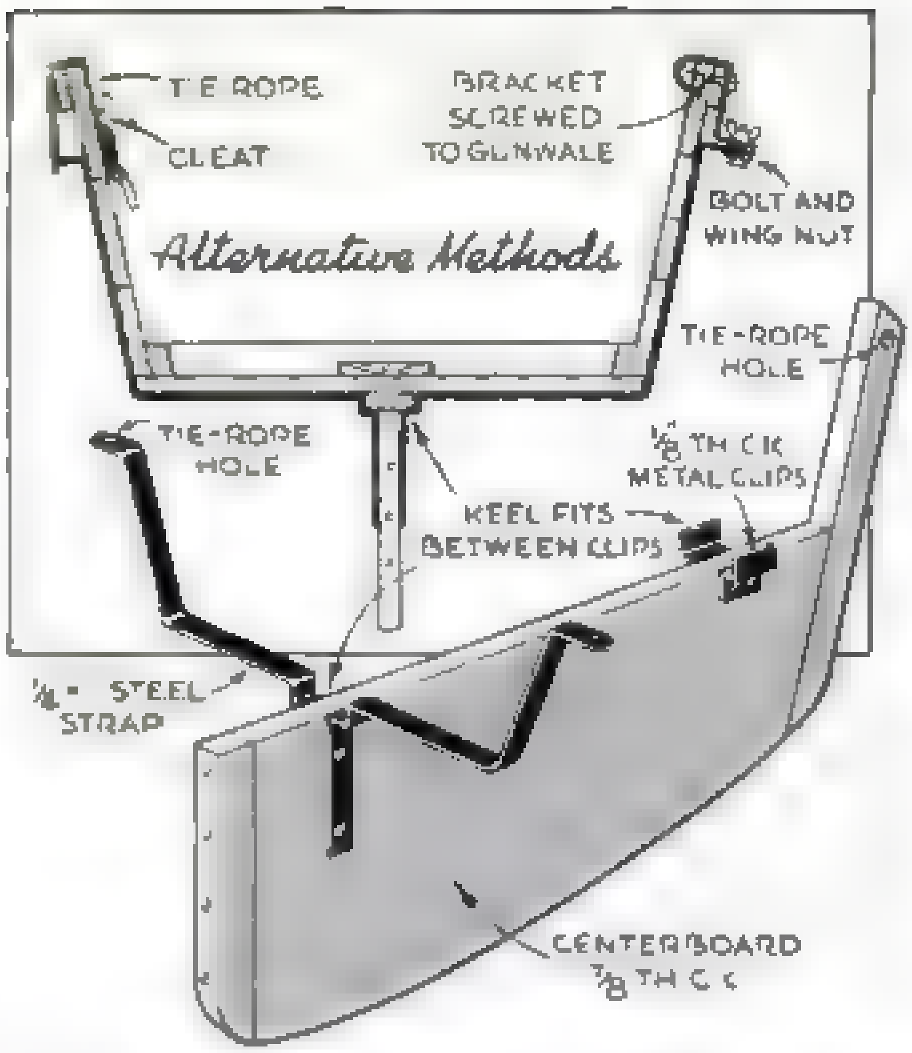
Projects shown were made by the following: Fig. 1, left to right, G. A. Lester, Akron, Ohio; Harry D. Fee, Muskegon, Mich.; E. B. Haffner, Baltimore, Md.; (small can) V. D. Stevens, Hillsdale, Mich.; Fig. 2, Wray W. Becking, Port Jervis, N. Y.; Fig. 3, Louis Terry, Lake Odessa, Mich.; Fig. 4, Fred Gottwalt, Lake Placid, N. Y.

Game-Court Lines Laid Out with Homemade Marker

A MARKER that will do an excellent job of laying out tennis or badminton courts, base and goal lines, and can be taken along on outings when desired, requires but a few minutes to be made from scrap parts. Punch a ring of small holes around the side of a 1-lb. coffee can and a ⅝" hole through the center of the lid and bottom. Use a long bolt, washers, and a wing nut to mount the can in a fork made by nailing two pieces of wood to a block slightly wider than the container. Bore a hole lengthwise in the block and drive in a short broomstick handle. To fill with marking powder, take the can out by removing the wing nut and bolt. Use regular court powder, and do not fill quite full.—GERARD BONVOULOIR.

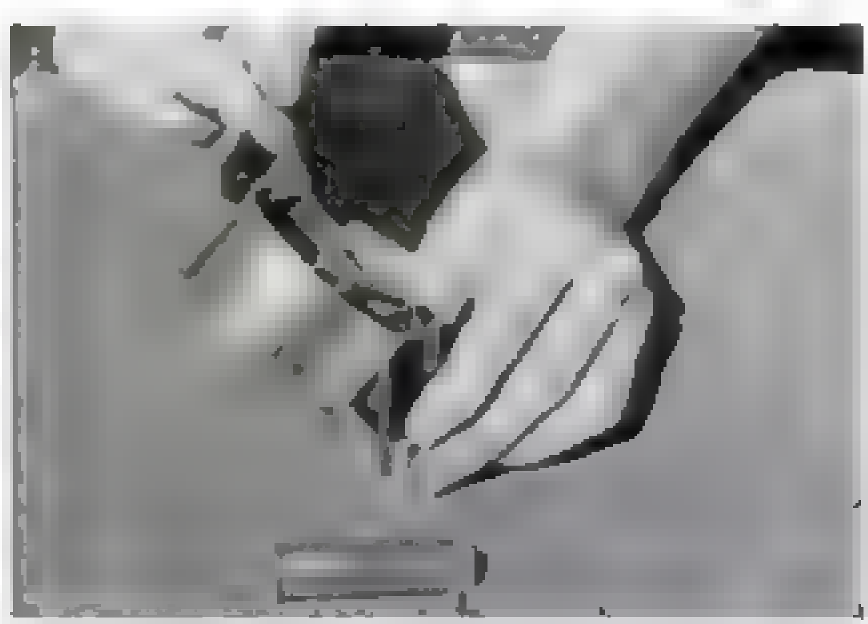
Used Shotgun Shell Holds Wax for Dressing Saw Blade

MELTED wax poured into an empty discarded shotgun shell will become, when hardened, a handy wax pencil that will be found serviceable for dressing saw blades and similar purposes. As the wax wears away, the heavy cartridge paper can be cut down or torn off to expose more wax. Homemade belt dressings of the solid type can also be put up in containers of this type for convenient storage.—STEPHEN LONGIN.



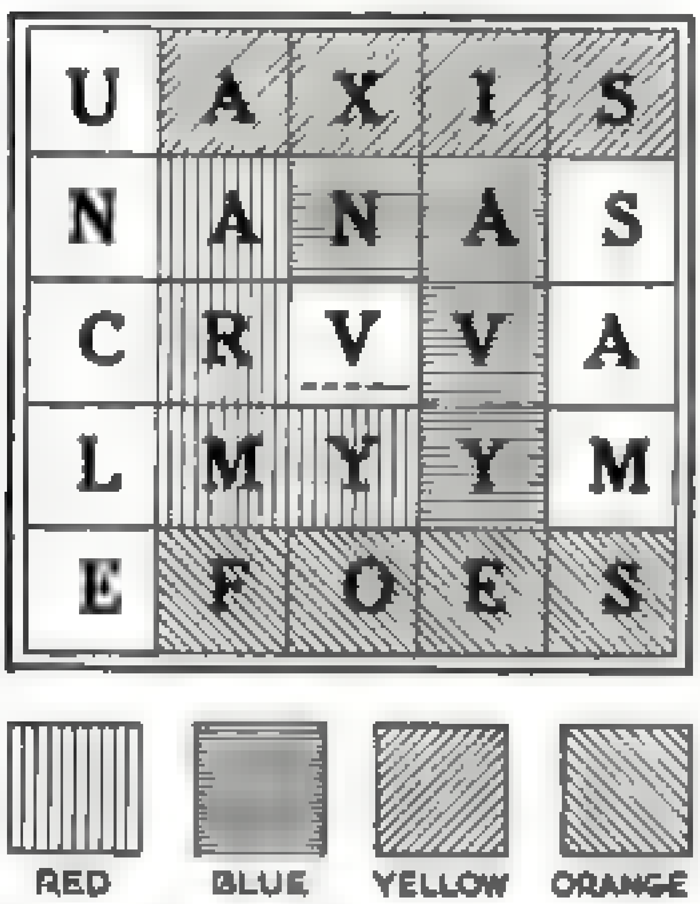
Detachable Centerboard Adapts Any Rowboat for Sailing

ANY sturdily built rowboat can be used for sailing by fitting it with the easily made centerboard shown in the drawings above, the only additional requirements being, of course, a mast and sail. This board needs no well in the bottom of the boat, and it can be detached readily at any time the craft is to be used for other purposes than sailing. The vertical legs of the metal straps aft, and two metal clips forward, engage the keel. Rope lashings secure the fittings inboard. An alternative method is to attach small brackets to the gunwales and use bolts and wing nuts to clamp the centerboard straps to them. For a round-bottom boat, the straps are simply bent in a curve to fit the contour. With slight modifications, the idea may be adapted for use even on a boat that has no keel—F. V. HARTMAN.



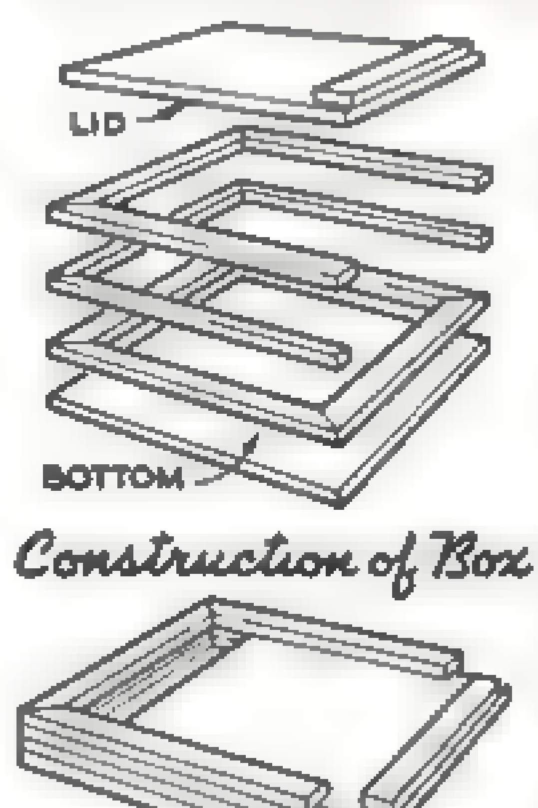
Strategy

. . . CAN YOU MOVE UNCLE SAM TO VICTORY IN THIS SLIDING-BLOCK PUZZLE?



Squares are sawed from thin stock or plywood, then lettered and colored as above. Right, how the box is made

Uncle Sam emerges victorious as the blocks slide into the position shown above. His Army and Navy support him, outflanking his broken foes



By ARTHUR L. SMITH

HERE is a block puzzle that will intrigue the lone player or furnish exciting fun for a group, as there will be keen competition to find who can help Uncle Sam beat the Axis in the fewest moves.

At the start, with the blocks arranged in the position shown in the drawing at the top left, Uncle Sam is in an uncomfortable position. The Axis foes hem him in with planes above and submarines below, and his own Army and Navy are outflanked and disorganized. The problem is to remove the center Victory block and slide the others about into the position shown in the photograph at the right above, where Uncle Sam is supported by the strong pillars of his Army and Navy, and the Axis foes are broken and surrounded. Only the Victory block may be lifted bodily from the board; all the others must be slid into position.

Saw out 25 blocks from ⅛" stock or plywood. Upon these paint the letters or glue on them white paper on which the letters have been printed or drawn. Suitable ones can perhaps be cut from a newspaper or magazine. Then color certain of the blocks as indicated, leaving the others white. This, appropriately enough, makes Uncle Sam and his Army and Navy red, white, and blue, while his enemies are yellow and orange.

The puzzle can be worked on any flat surface, but is far more satisfactory if fitted into a box such as the one shown above.

Lathe Tools for Special Jobs Ground from Flooring Nails

VERY small lathe tools for a variety of special jobs can be made by grinding standard hardened flooring nails (at about 15 cents a pound) to the desired shape. The very gray nails seem to be harder than the blue. The steel is surprisingly good in spite of its low cost, and the nails are stiff enough to take fairly heavy cuts. In grinding these bits, the usual precautions against overheating must be taken.—MALCOLM HILL.

Gas Models and Towline

Demountable model planes find favor when fliers travel or have limited storage space. This one built by Ralph Rapien, of Chicago, packs into a case and can be assembled quickly with pegs, rubber bands, and hinges

By
FRANK ZAIC

MODEL-AIRPLANE making is entering a new era. Shortages of many materials previously imported may reduce the number of construction kits on the market, and more builders may be inclined to design their own ships.

Gas models. Whether a gas model is made from a kit or built to an original design, too much stress cannot be laid upon the need for aligning all parts perfectly. Once you have a true line-up, any basic faults may be more easily checked. If some structures seem to be weak, replace them with stronger ones.

As a rule, the high-powered, high-wing model is one that will call for critical adjustments. Its natural flying characteristics are a right spiral climb under power and almost anything in the glide. Use low power on the initial flights to learn the eccentricities of such a model and correct them before it cracks up.

In designing a gas model yourself, count on having the wing slightly above and behind the motor. The reason for this is to bring the center of gravity closer to the trailing edge, or about 60 percent of the wing chord back from the leading edge, and still have the motor accessible and the heavy ignition system near the wing.

Wing design and construction may be much the same as for rubber models. The stabilizer need not be larger than 25 percent of the wing area, and the rudder may be made 10 percent to start with and altered if test flights show it necessary.

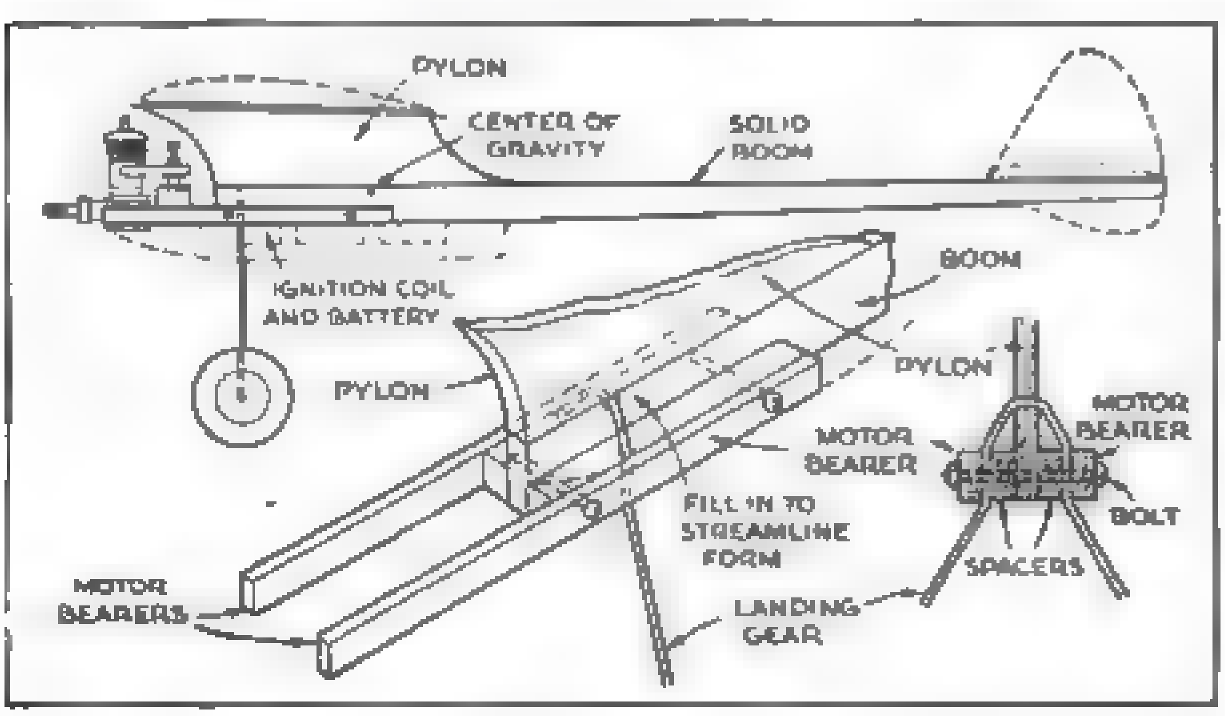
Gliders

Homemade folders as a rule are too stiff to fold back, but commercial ones do and aid greatly in saving propellers. There are three blades on the prop below, made by a builder in New Jersey. The number doesn't matter as all can be folded back

This is the Cabina model shown dismantled and also packed in its carrying case on the facing page. Here Rapien has attached his folding wings, stabilizer, and landing gear, installed motor and propeller, and is set for the take-off

A great deal of freedom is possible in designing the fuselage, especially since new competition rules place no limits on cross-sectional area. A fuselage that the writer is developing is shown in the drawings. The boom is cut from hard balsa. It was found that a hollow boom snaps easily, whereas a solid one of the same weight merely bends and springs back.

Perhaps the greatest difficulty in designing a gas model lies in planning the motor mount. Aluminum, if available, is good for small motor mounts, especially if used as removable units to which the batteries and coil are affixed. The drawing shows a mount used by the writer. The wooden bearers are attached to the boom with only two screws, and a broken bearer can be replaced readily. This mount also clamps the two-wheeled landing gear in place.

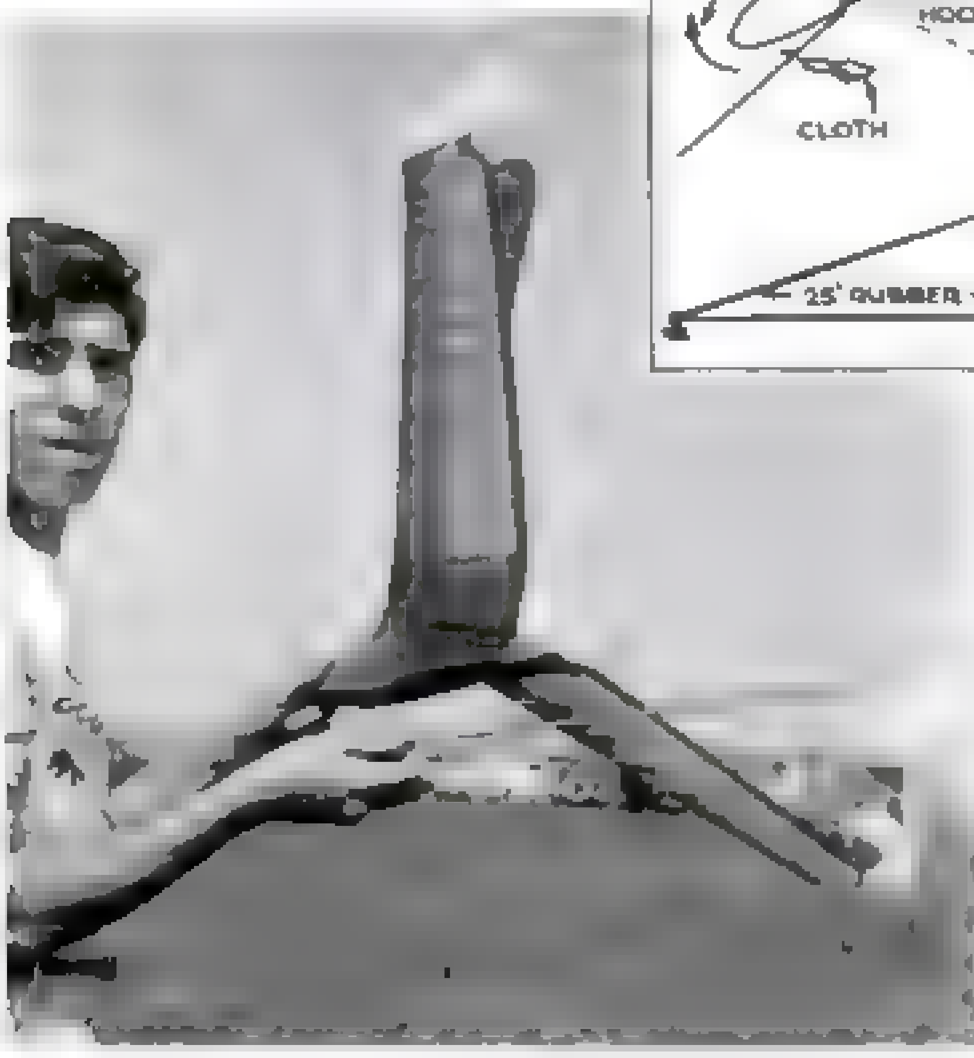


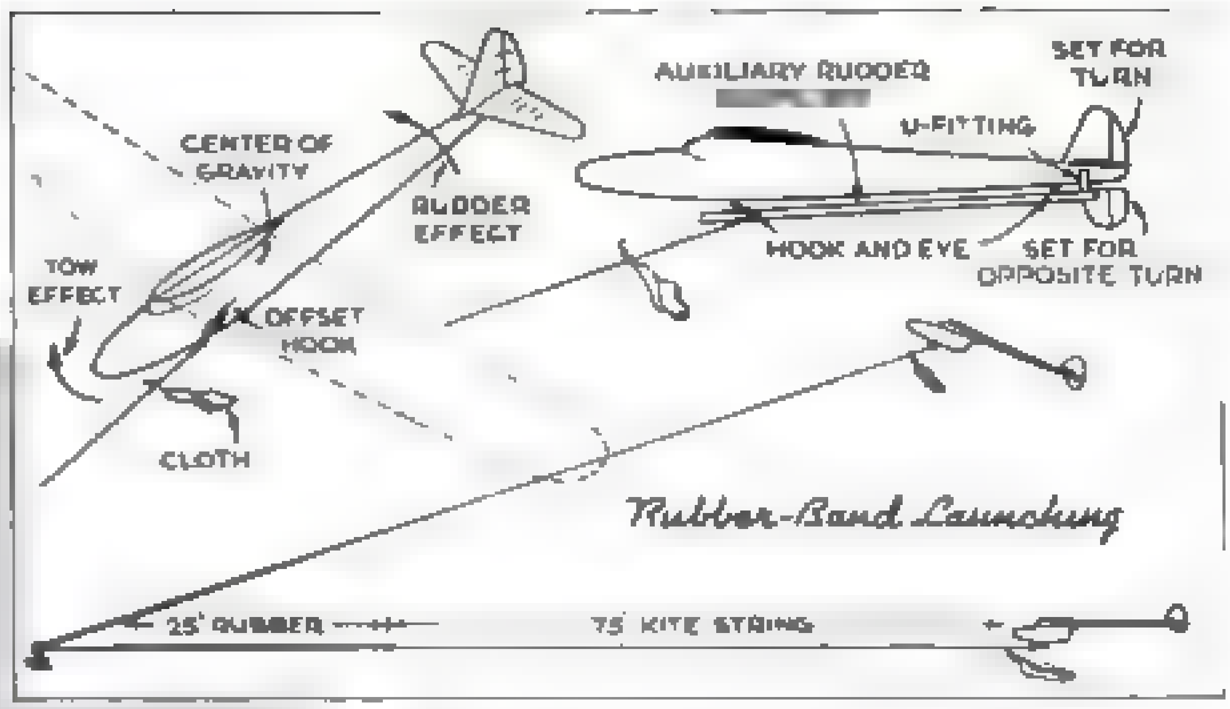
Design of a practical motor mount. Wooden bearers are attached to the boom with only two screws, facilitating replacement of a damaged bearer

Competition rules still require an adequate landing gear. With the single-wheel type, two auxiliary skids must be used. Retractable landing gears reduce drag slightly, but are scarcely worth the extra difficulty they entail. Also, builders too often forget, in the excitement of getting the motor started, to put retractable gears up.

Few rules can be laid down for handling gas motors. Learn their little

Harry Apoyan and his tailless towline glider. The stick to which the towline is attached has a rudder. When the glider reaches the peak of its climb, stick and towline fall away, leaving the model free to soar





With a fourth of the towline of rubber, a glider is launched at gradually increasing speed, often adding surprising altitudes

tricks. It is most important to make sure there are no compression leaks from the crankcase or elsewhere. Breaker points should be made to close evenly and not on one edge only.

One should also remember that the life of a battery depends on its weight. Use the largest possible. Voltage drops appreciably after cells have been in service a short time, so use boosters as much as practicable.

The rules permit a maximum flight duration of only four minutes. Any time over that is subtracted from four, and if the flight is six minutes or more, no time is taken. The reason for this unusual rule is that gas models must be kept within the flying area so as not to interfere with the spotting of military aircraft.

Gliders. If the shortage of balsa and rubber continues, we shall have to turn to towline gliders. These can be made from domestic woods and paper without consideration of weight. One needs only a long string to get them up as high as may be desired, although contest rules allow only 100' of line.

The design of a towline glider is not very different from that of a rubber-powered model. Its fuselage is usually one half the wing span. The aspect ratio of the wing may vary from 8 to 12, the former being more efficient in the case of small wings.

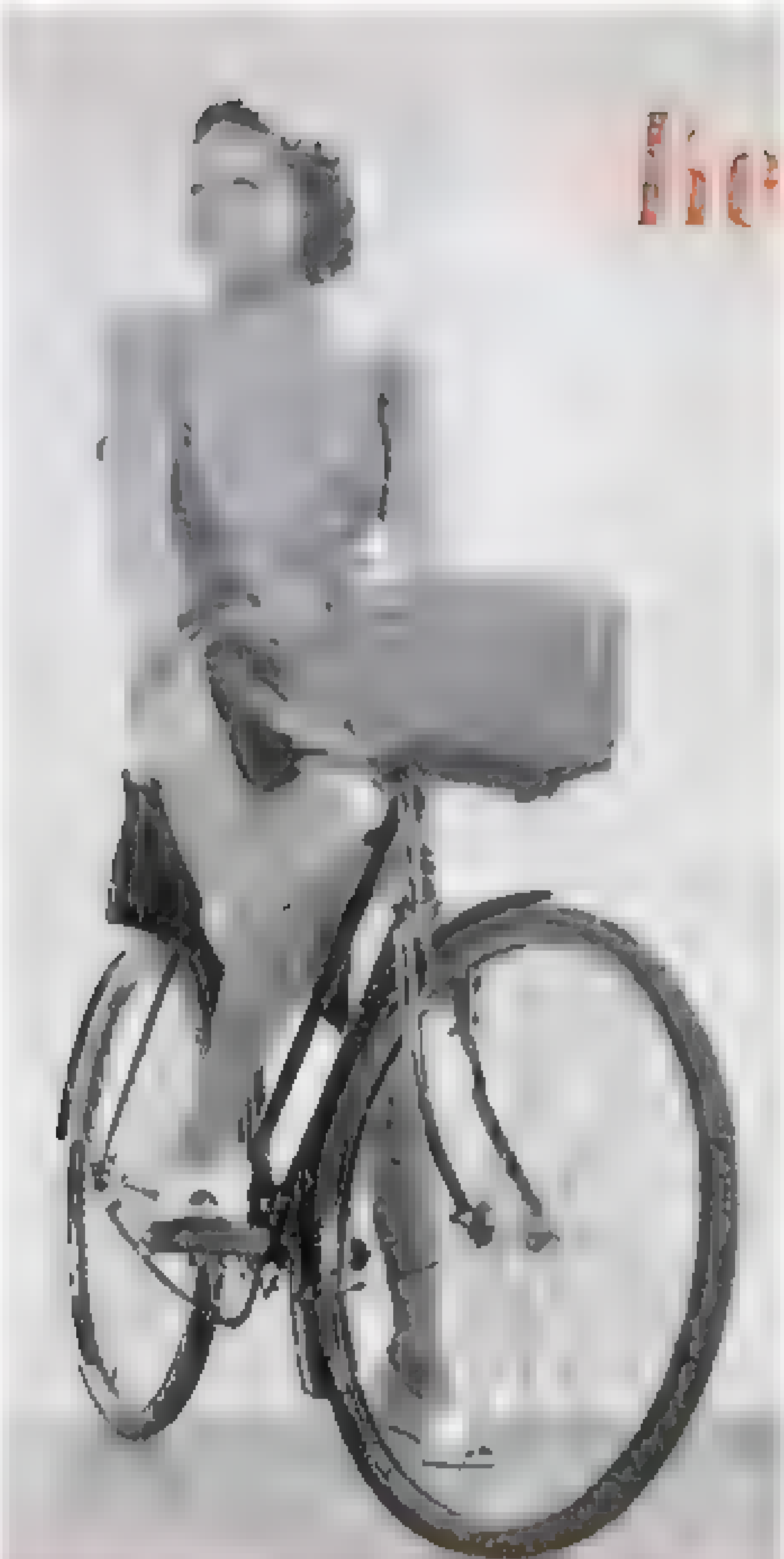
The chief thing to be watched is spiral stability, so that the glider will not spin under tow or in a thermal current. Use about 1½" of dihedral under each wing tip for every foot of span, and use polydihedral when possible. Careful adjustment of the rudder area must be made by observing the model in flight or glide. If it persists in facing the wind, the rudder is too large. If it tends to glide with the wind, the area is too small. The action is almost exactly like that of a weather vane.

If the rudder and dihedral are correctly proportioned, it is possible to tow the model upward with the rudder set for a circular glide. To do this, some fliers attach the towline to one side of the model, thus offsetting the effect of the turned rudder, as shown in the drawings. Others use a lever arrangement between the tow hook and the rudder so that the latter will remain straight under tow, but turn when towing is over.

One glider builder, Henry Struck, of New York, N. Y., designed an auxiliary rudder that is attached to the towline and drops off with it when the glider is released. Most fliers tie a bit of cloth to the towline near the glider. Wind drag on the cloth helps the line free itself from the hook.

An excellent launching method shown in the drawings makes use of both rubber and towline. About one fourth rubber to three fourths line is a good proportion, and a single ⅛" strand is adequate for 4-oz. to 6-oz. gliders. This launches the model at gradually increasing speed; surprisingly high flights can be made in this way

Glider flying affords great satisfaction. It is particularly exciting since a flight may be prolonged astonishingly if the model encounters a thermal.



Keeping Your Bicycle Fit

By GILBERT RAE SONBERGH

SHORTAGES of gasoline and rubber have turned America once more to the bicycle for essential transportation as well as healthful fun. Thousands of men and women have found cycling a pleasurable sport, a dependable means of travel, and a form of exercise neither too mild nor too strenuous—a revival of a youthful interest that bids fair to retain its adult popularity for many years.

Tremendous potential mileage is built into the modern bicycle; yours should render trouble-free service almost indefinitely if it is properly cared for and the few parts that wear out are replaced.

An adequate maintenance program must include regular cleaning, oiling, and adjustment every 200 miles or every month, whichever interval ends first. The pedal, wheel, crank, and head bearings should be given a few drops of *light* motor oil. If the coaster brake slips, run a few drops of kerosene into the oil cup in the rear hub and spin the wheel a few times by hand. Follow with a drop or two—no more—of light motor oil. Don't use thin sewing-machine oil.

Test the spokes when making your periodical inspection. Any loose ones should be tightened with a special wrench that fits the nipples in the rim. Take care, however, not to warp the wheels out of line. Rotate each, noting whether the rim runs true in the fork. Rims can be trued by tightening or loosening alternate spokes, but all spokes should be reasonably taut when you're through. It is often best to leave spoke adjustment to a bicycle repair man.

Inspect the chain, replacing weak or damaged links with "master" or snap-on links. A chain break on the road can throw the rider and damage the rear wheel assembly. With a stiff brush and kerosene, remove grit and dirt from the

WHAT TO DO EVERY 200 MILES

Clean off dirt
Check coaster-brake action
Inspect chain for weak links
Oil and check adjustment of:
- wheel bearings
- pedal bearings
- crank bearings
- steering-fork bearings
- chain

Examine wheels for loose spokes
Check height of saddle and handle bars

REAR WHEEL. Tighten loose spokes with a special nipple wrench, then spin the wheel slowly to see that it runs true, tightening and loosening alternate spokes until all rim "wobble" is gone. To take off the wheel, remove the bolt securing the coaster-brake arm, then loosen the axle nuts and back off the tension screw, slide the wheel forward in the slotted fork, and take the chain off both sprockets

DRIVING MECHANISM. Locate the master or snap-on link and hold it as at the left below. Bend it to compress the side nearest you. The cover plate can then be lifted off. Clean the chain, examine for faulty links, and lubricate it. Also inspect the sprocket teeth. Remove the crank by taking off the left pedal first, then the crank lock nut, keyed washer, and cone (all have left-handed threads). To maneuver the crank bend through the hanger, hold the ball retainer against its cone. Clean and grease

STEERING HEAD. For periodical cleaning and greasing of the head bearings, unscrew the expansion bolt in the stem extension about ¼", tap it gently with a hammer to loosen the wedge nut, and then lift out the handle-bar assembly. The tapered wedge nut (center photo) has flanges which fit the expanding slot. Take off next the head lock nut, keyed washer, and cone, and slide the fork and stem down and out

chain; then run oil along the sideplates of each link. When the links work freely, wipe off excess oil; too much will collect grit, which will eventually work into internal bearing surfaces.

An ideal method of lubrication is to work small amounts of oil into the inside link bearings and rub stick graphite on the sprocket teeth and chain rollers. Stick graphite alone will not suffice, as it cannot penetrate to the inside bearing surfaces. Oil alone, however, is quite satisfactory.

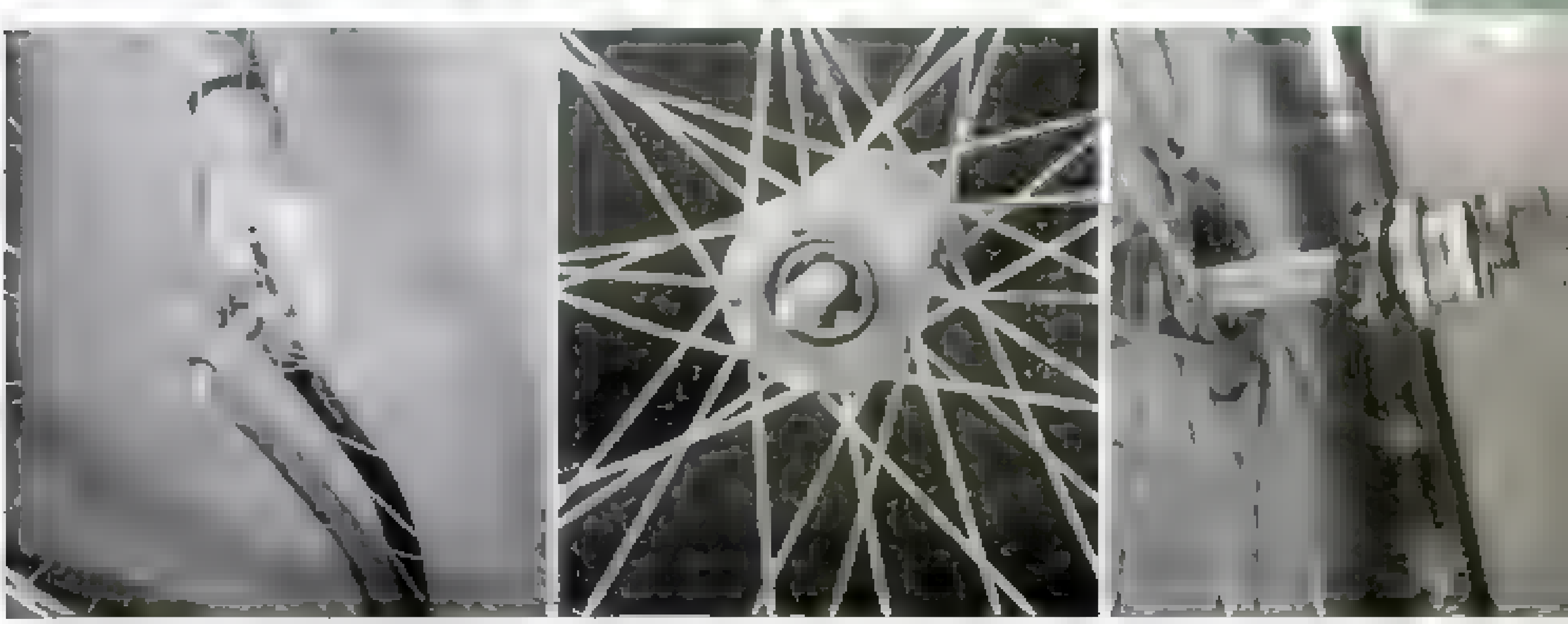
If the chain is very gritty or caked with mud, remove it and soak it in kerosene. Then dip it into an oil bath, working it back and forth until the oil has penetrated the rollers. Wipe off the excess.

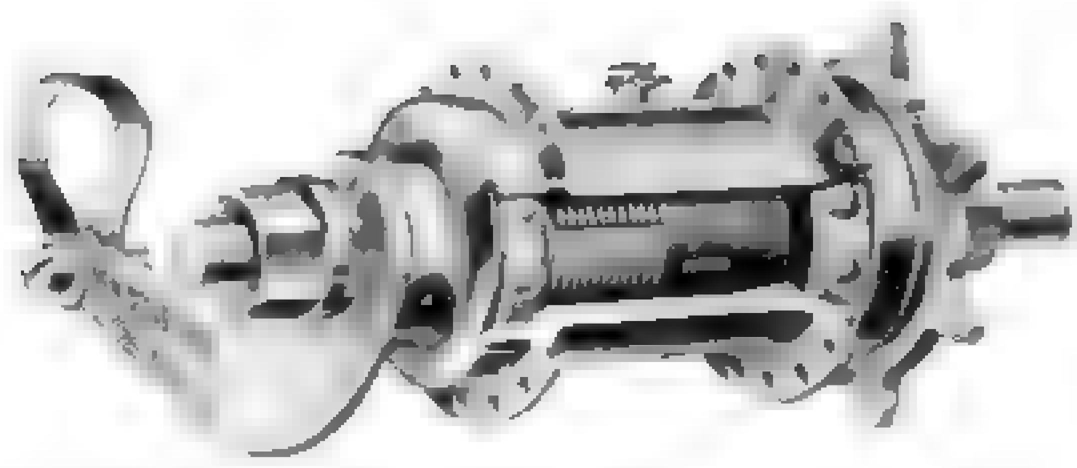
Before replacing the chain, sight along the sprockets, to see whether they are in alignment. If sprocket teeth are badly worn, the sprockets should be replaced, particularly if a new chain is to be installed.

Replace the chain and adjust it by turning the long, square-headed screw that bears against the axle. With the top of the chain taut, the lower half should sag no more than ½". Turn the crank slowly, feeling the chain to be sure there are no tight spots, for if it is slack in one position, tight in another, uneven wear is indicated and both chain and sprockets may have to be replaced. Sight again with the chain in place to make sure it tracks properly.

Bearing cones in the hubs, pedals, crank hanger, and head should be checked regularly for free running without binding or wobbling. Attention to bearings pays dividends in long service. The rear-wheel adjustment cone is always on the left side. If dust and grit have worked into a bearing, place it

FRONT WHEEL. To remove this wheel, simply loosen the axle nuts (or remove them if there is a mud guard) and lift it out of the slotted fork. Unscrew the cone with care, paying particular attention to the way the ball-bearing retaining rings face, for replacing them backwards will cause damage. To keep from dropping the balls, stand the wheel straight, withdraw the axle with one hand, and catch the retainer on the other side with the other. Some bikes have no retainer here, and require greater care





COASTER BRAKE. Lay out all parts in a row with utmost care as you remove them, noting not only the order of removal but also the way each faces, for a mistake can prove costly

with its axle vertical, back off the cone, and pour in kerosene, revolving the part slowly until the dirt is washed out at the other end.

The 200-mile check should include adjusting and tightening the saddle, all nuts and bolts, and the handle bars. The tip of the saddle should be on or slightly behind a perpendicular line through the center of the crankshaft, and the seat post clamped at a height that allows the heel to touch the pedal at its lowest point. Handle bars should be of the standard flat-top type and as wide as the rider's shoulders, and the rubber grips must be cemented firmly. Adjust the handle bars to bring the grips level with the saddle. The rider will then lean forward at a slight angle, most of his weight being on the pedals and saddle.

To help keep dirt out of the bearings, the frame should also be cleaned at the 200-mile mark. A coat of automobile wax will aid in keeping it clean. Wipe plated parts with an oiled rag, or use metal polish.

Once a year your bike should be taken apart completely. If used daily, for long trips, in rain, or on dusty or muddy roads, a semiannual overhaul is advisable.

Every shaft, cone, and bearing should be thoroughly cleaned in kerosene, repacked with light grease or petroleum jelly, reassembled, and adjusted. Lay out in order or label all parts as you remove them so that each can be put back in its original position. Replace any badly worn parts.

Coaster brakes must be taken apart with utmost care. Lay out all parts in a row as you remove them, noting not only the order of removal but also the way each faces. Replacing any part incorrectly will result in faulty operation and bad wear.

Tire inflation should be checked every few days. The narrow shoe-and-tube tires on modern bikes carry 50 to 60 lbs. pressure. If it is not marked on the sidewalls, consult your dealer. Nothing wears like underinflation. Examine tires daily for nails or bits of stone or glass in the tread. Inner tubes can be patched like automobile tubes, but be careful not to pinch beading or tubes when removing. Single-tube tires can be "puncture-proofed" with 6 oz. of molasses or a commercial compound. They should be shellacked to the rims.

Never leave your bike outside in rain or heavy dew. Don't ride another person on it. Jumping curbs may break the tire walls. Don't depend on your coaster brake alone if you descend long hills often, but install an extra front-wheel caliper brake. Friction develops terrific heat in the brake if you use it for prolonged periods. Avoid "jamming on" the brake and save tire wear.

If you buy a bike, get a "lightweight" for easy pedaling. The new "Victory bikes" are lightweights, about 35 lbs. fully equipped. To select the proper frame size, take your inside leg measurement from crotch to heel and subtract 9". This should correspond to the length of the seat-post mast, from crank hanger to top bar.

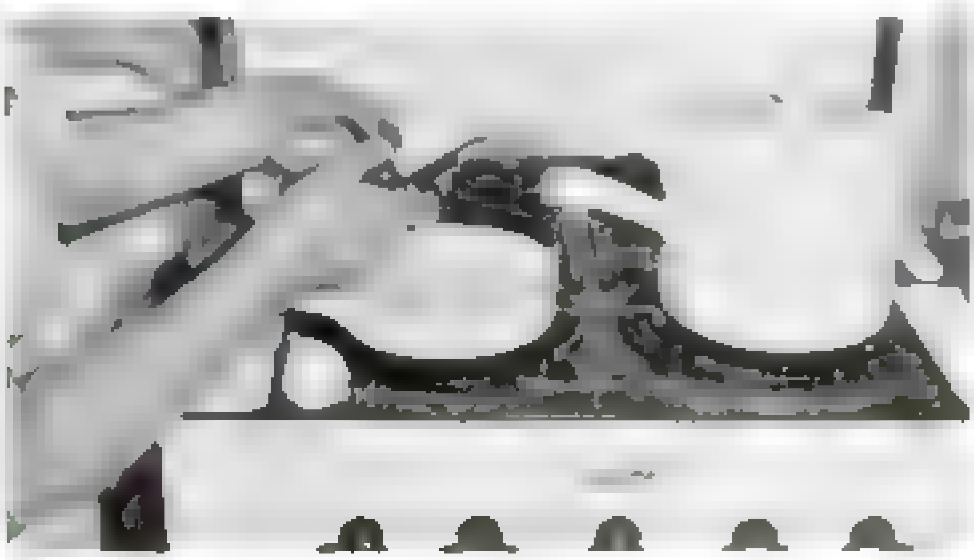
Care should be exercised in determining the gear ratio for your size, weight, and strength. Men take gearing from "64" to "74," women from "54" to "64." This number is the diameter in inches of a wheel traveling in one revolution the distance the bike would travel with one revolution of the pedals. The expression dates from the days when the pedals were on a large front wheel. A high gear means, therefore, less pedaling, but greater effort; low gear, desirable in hilly country, greater leverage and more effective power. Since any will be a compromise, a two-speed gearshift mechanism inside the coaster brake is worth while. This usually costs only a few dollars extra.

To calculate the gear, multiply the number of teeth in the large sprocket by the diameter, in inches, of the rear wheel, and divide the product by the number of teeth in the small sprocket. You can change the gear ratio by using a different size rear sprocket and adding or removing links to make the chain fit.

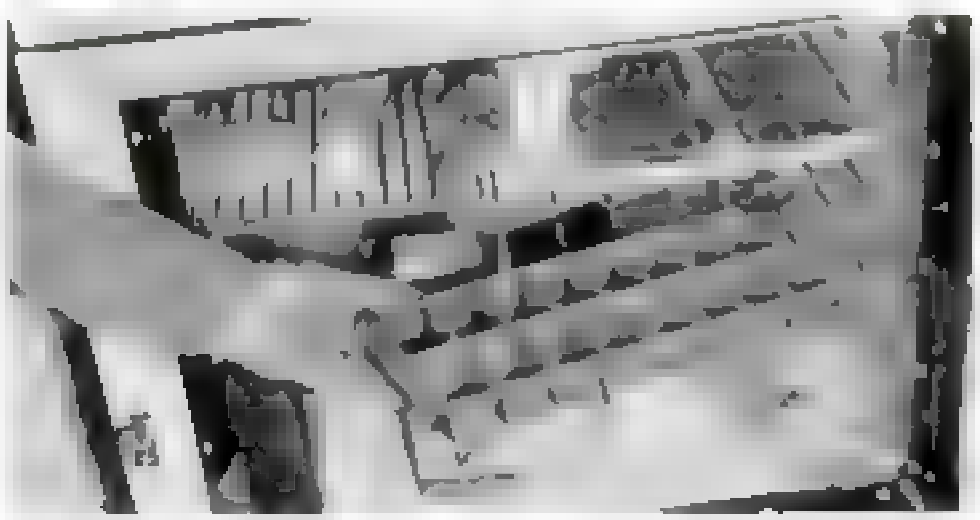
And now you know how to select a good bike and take care of it; but do you know how to use it to get the greatest pleasure with the least effort? There is only one trick—pedaling. Take a tip from the experts: Keep the ball of the foot squarely on the tread; exert power through *more than half* of each revolution by tilting each foot up near the top of the stroke, down near the bottom, thus pushing the pedals past dead center instead of merely letting them coast over. Keep the knees in, parallel to the top bar. The resulting smoothness, speed, and power will surprise you.

NEW APPLIANCES to aid in *Housekeeping*

TINLESS TIN CANS have made their appearance in the home, and among the most recent is the group shown at right which includes several designs, all laminated cardboard and airtight, moistureproof cellulose film. Depending on the nature of their contents, some use film inside and out, some between cardboard layers, some cemented inside layers of paper bags, and some are just bags of the film fitted into cardboard cartons



CERAMIC COOKING UTENSILS, finished in cream porcelain instead of having the customary glazed earthenware appearance, are available in a 16-piece line suitable for either the stove or the table. There are skillets, casseroles, a double boiler, three sizes of saucepans, and also plates, cups, and saucers included in the pieces. The special porcelain finish is made with minerals which prevent breakage from heat



FLEXIBLE, PLASTIC ICE-CUBE TRAYS, built in one piece with no extra parts or gadgets and having a sturdy finger-grip to assist in nonsticking removal, are on the market in a 4¾" by 10½" size that will fit the freezing chamber of all standard refrigerators. Each tray has capacity for making 16 generous ice cubes and, being flexible, can be twisted so that cubes can be taken out for use singly or in quantity without holding them under running water

HANDSOME BLACKOUT DRAPES have been made up for everyday use at windows and for quick protection against light leaks in an emergency. The curtains are tailored of a lightproof, lined material ample to cover a window completely should the need arise. Ordinarily they are draped at the sides, held by metal ties, and serve the same purpose as any decorative drapery, but when necessary, the ties are released and the curtains drawn and fastened to each other at the center by a mesh-type metal fastener. For an additional guard against light leakage, they can also be secured at the outer edges and bottom with hooks, snaps, or thumbtacks

Care and Repair of RUBBER Articles

By WALTER E. BURTON

RECENTLY a paper mill was badly in need of a 6-ply rubber belt 20" wide and 42' long. Rummaging through a collection of odds and ends, workmen found a 32" 8-ply belt, 56' long, which had seen several years of service but was no longer used. The badly worn top and bottom plies were stripped off. Then the belt was slit into one 20" and one 12" width. The ends of the wider strip were trimmed and vulcanized together to form an endless 42' belt; the remaining strip was slit to make 112' of 6" 6-ply belting. When mill officials finished adding up figures, they found that, at a cost of $36.10, they had a stock of 6-ply belting worth $279 if purchased new. But, best of all, they had saved 80 lbs. of crude rubber that would have been required to make that much new belting.

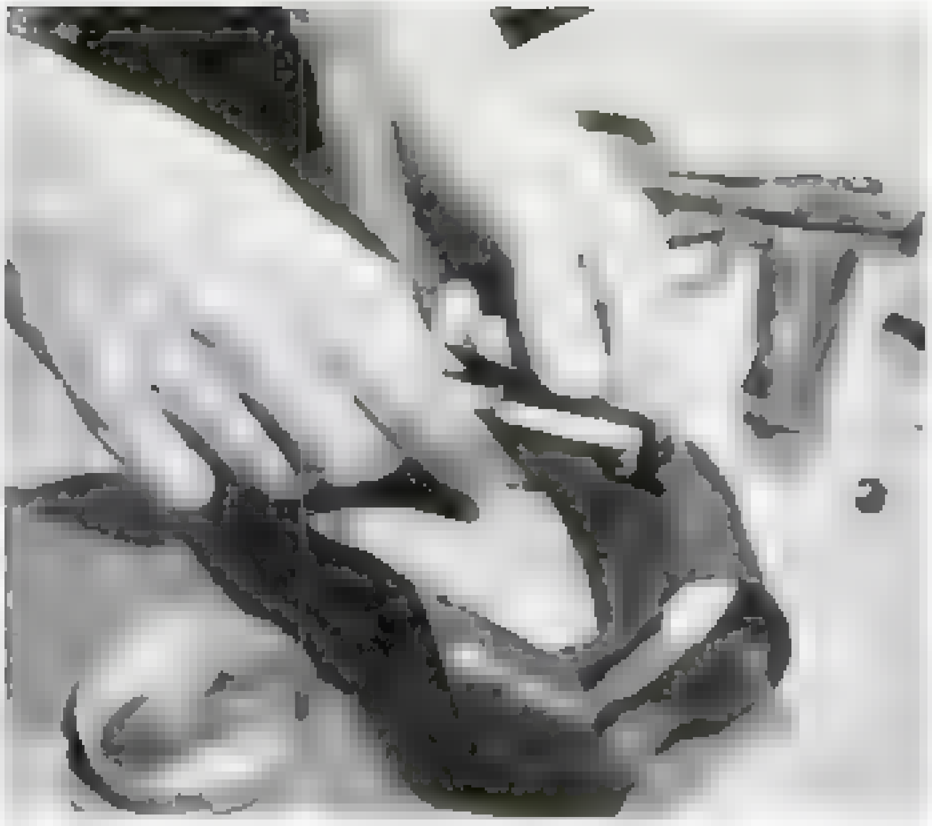
In such ways industry is trying to make the nation's rubber stretch as far as possible. Similar practices are prolonging the usefulness of rubber articles in American homes and small shops and teaching users of rubber new facts about its properties and behavior.

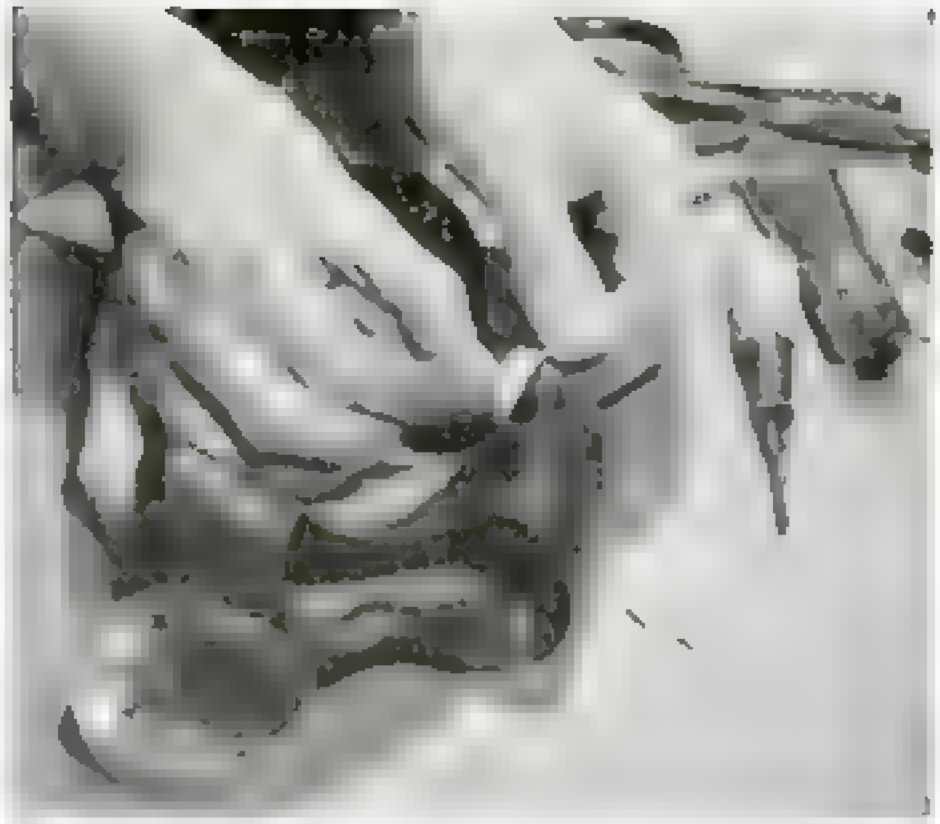
Specialists at a large rubber company suggest an experiment anyone can try: Obtain two rubber bands and three nails. Drive one nail into the sunny side of a building, and hang one band on it. Near by drive two nails and stretch the second band around them. In about three days, inspect the bands. You will find that the stretched one has cracked and perhaps fallen off, while the other is still in good shape—although it, too, will succumb in time to the action of light and heat.

This demonstrates how rubber under stress is more easily damaged, and how untold numbers of overshoes, quantities of boots and hot-water bottles, and miles of fire hose are ruined every year. Are your rubbers, for example, slowly deteriorating at this moment because you tossed them into a corner and stood an umbrella on them? Any form of pressure or distortion subjects rubber to stress like that which hastened the ruin of the rubber band in our experiment.

Use water and a brush to clean all dirt off rubber footwear before you put it away. If you have walked across the garage floor, your overshoes have probably picked up grease and oil—two of rubber's insidious enemies. Scrub the soles with soap and water, trisodium phosphate, or a solvent such as acetone or nonleaded gasoline. Be sure to wash off all traces of soap or phosphate with water. This method of cleaning can be used for any rubber article.

Store rubber shoes in a cool, dry, *dark* place. If you have no dark closet, wrap them in paper or put them in a box in a nat-





Don't throw away those overshoes just because you snagged them on a stone. You can repair them with the aid of a cheap patching kit and get many months of wear. After cleaning and drying the damaged spot, roughen the inside surface with a grater as in the photograph on the facing page. Next (above left) apply rubber cement work it into the cut with a screw driver or similar tool, and let it dry for a few minutes. Then trim a piece of the patching rubber to fit, peel off the protective layer, and press the patch on. Being inside, it won't show

tural position, not folded or crushed. The same applies to carrying spare rubbers in your car. Don't walk in them over sharp cinders or broken glass, and remember that rubber cuts more easily when wet.

Enterprising shoe-repair shops offer patching service for overshoes, water bottles, and similar rubber articles. The life of such things may be prolonged for months by the prompt repair of a small hole. Kits for cold patching are convenient for doing such work at home. Clean all grease and dirt off the damaged part, roughen the area around the hole with the grater provided or with sandpaper, and work some cement into the rubber with a knife. Strip the protective cloth from a piece of the patching material and roll its tacky rubber surface into intimate contact with the cemented area.

This simple repair is satisfactory on many rubber articles, including inner tubes. However, many users prefer a heat-vulcanized patch for inner tubes. Hot patching is necessary on conveyor belts and other articles subjected to severe service, although frequently a cold patch may be put on temporarily to serve until the repair can be vulcanized.

Some years ago a fire broke out in the janitor's closet of a high school. Two sophomores, happening to pass, discovered it. In the hallway was a fire hose, neatly folded in a metal rack. The boys unlimbered it and opened the valve, but to their dismay more water came out through the sides of the hose than through the nozzle. The janitor had been as neglectful of the hose as he had of the oily rags that started the fire.

Fire is a relentless enemy at all times. It is highly important that equipment for fighting it be kept in top-notch condition. Fire hose ought to be of the flat-cured type, which can be stored flat without cracking. When placing it in a rack, fold it as little as possible. Every three months, rearrange it so the folds come in different places; every six months, run water through it to keep it

HOW TO GET LONGER SERVICE FROM RUBBER

1. Keep rubber articles out of sunlight.
2. Don't expose them to excessive heat or cold.
3. Clean off oil, gasoline, or grease promptly.
4. Remember that rubber is more easily cut when wet.
5. Avoid kinking, constant bending, and crushing.
6. Don't leave a hose under pressure. Rubber under tension deteriorates faster.
7. Avoid letting hose, mats, and the like become waterlogged. Drain and dry occasionally to prevent mildew.
8. Keep rubber away from sharp edges or rough surfaces.
9. Use soap and water, trisodium phosphate, or acetone for cleaning rubber. Rinse well afterward.

Periodic cleaning of grease and oil from V-belts makes them last. Use a solvent, but not too much

Do you shut off water in your garden hose this way? Kinking on the ground can be just as bad

It's back to the paintbrush for the owner of this sprayer unless he learns not to kink the air hose and not to drag the motor cord around sharp edges

from becoming brittle. Drain and let the excess water evaporate before replacing the hose. If it is not dried inside and out, the fabric may mildew.

Should oil adhere to the hose, remove it with soap or a solvent. Neutralize any acid that may get on it by applying a 5-percent solution of washing soda. A break in the fabric cover can be repaired by darning, or by application of rubber cement, varnish, shellac, or other water-resistant material.

Sunshine and heat destroy tons of rubber in the form of garden hose. Such hose should be rolled up and placed in a dark shed or in the basement; if its reel is attached to the house, a light-tight cover having the sides and front hinged should be built around it.

Contrary to common belief, water *will* harm a hose or any other rubber article containing fabric. It gradually penetrates the rubber, spreads through the fabric, and causes mildewing or rotting. Don't let water remain in your garden hose. This is especially bad if it is in danger of freezing. Drain the hose by progressively arching it upward, and let it dry inside before storing it for long periods.

Another common cause of damage to all types of hose is sharp bending such as that caused by kinking, hanging the hose on a nail, or squeezing it double to shut off the flow through it. Stepping on a hose or running over it with an automobile, wheelbarrow, or even a toy wagon shortens its life. Hose should always hang downward from a faucet or other outlet to which it is attached. Using the nozzle instead of the valve to shut off the water in a garden hose is a common practice that should be discontinued except for very short periods.

Rubber mats and matting generally give long service even when abused, but sweeping, scrubbing with water, or brushing at regular intervals will be well repaid. Lime deposits from hard water can be removed with scouring powder, followed by soap-and-water scrubbing and thorough rinsing. Do not bend, kink, or hang a mat over a register to dry it. Wipe oil and gasoline off at

In replacing a lost stopper on a tube of rubber cement, a common wood screw serves efficiently

Worn outside plies can be stripped from heavy flat belts, making them suitable for lighter work

once. If possible, place mats where they will not be exposed to bright light. Do not drag heavily laden trucks or sharp-cornered objects over them. When installing such rubber floor covering, trim it—don't compress it—to fit the space.

V-belts are today so widely used that their conservation is vital to all of us. Periodic cleaning with a gasoline-moistened cloth to remove oil or grease will add a million round trips to the life of such a belt. However, avoid excessive wetting with gasoline.

A spare V-belt should not be hung over a nail, but should be draped over a broad, rounded surface or kept flat in a drawer. Looping it to fit into less space isn't particularly harmful. Idle belts should be kept in the dark. Drives can be protected from light—and fingers from the belts—by inclosures of wood, metal, or canvas.

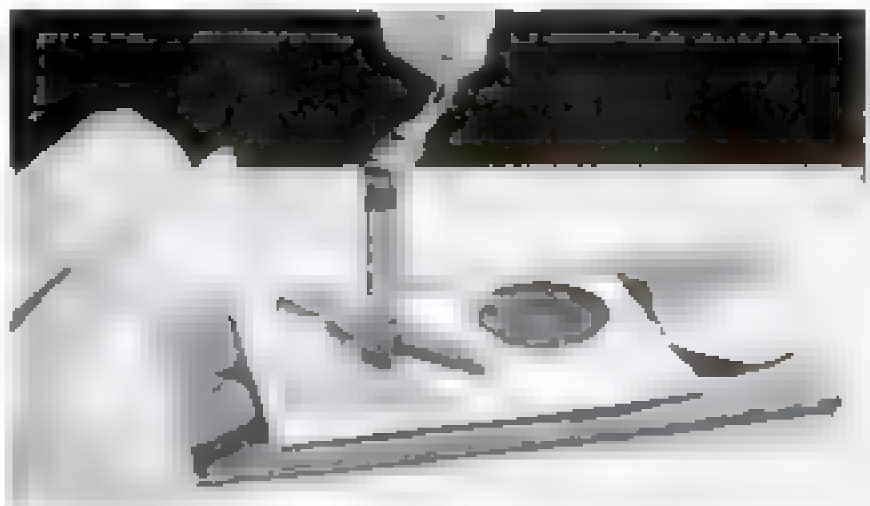
See that belt sheaves remain in line, that burrs, dirt, and worn places in the grooves do not punish the belt, and that the tension is correct.

On some drives, the speed is changed by stretching a belt over the pulley flanges from one groove to another. Some device should be provided to make it possible to slacken the belts for this purpose. Factories using multiple-belt drives save rubber by standardizing on one size of belt. When one in a drive needs replacing, all of them are removed and new belts installed. The usable old belts are rematched for other drives. If a new and an old belt are run together, one is likely to wear rapidly or break because of uneven tension.

A surprising number of flat rubber belts are used for transmitting power and conveying materials. These belts have several lives. When outside plies are worn, they are stripped off with carpenter's pincers, exposing fresh plies. The belts can be cut into narrower widths and their edges sealed against moisture. Thus an 8-ply belt can be reduced to a 6-ply, and later on to a 4-ply.

If you use a rubber belt, remember that it may be damaged by any dressing that penetrates the rubber. Rosin should not be used.

Damaged places in transmission belts are easily repaired with vulcanized patches. The injured section is cut out smoothly with a gasket cutter

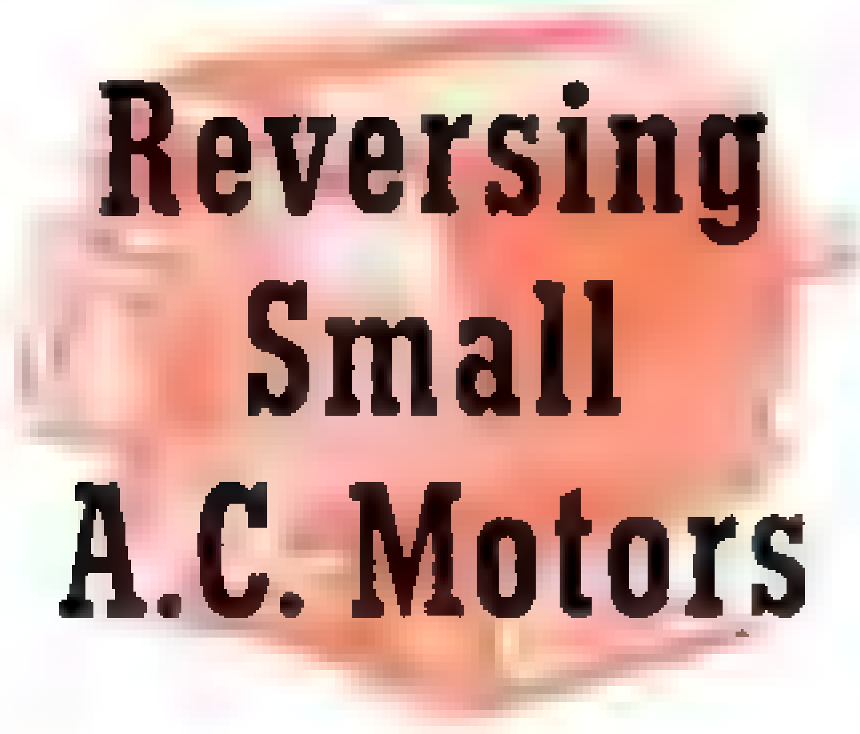


Uncured rubber cover stock is cut the same size as the spot in the belt prepared for mending, and then fitted in, as below, ready for vulcanization

The surface of a new or glazed belt can be improved by applying a vegetable oil such as boiled linseed, tung, or castor oil. Never use a mineral oil or grease on rubber.

Give rubber goods the best care possible. Keep rubber cushions and mattresses covered at all times with fabric to keep light from them. Rubber tire paint, while not particularly beneficial to a tire in actual use, can be applied advantageously to spares, to the rubber trim around tail lights and running boards, and to various household articles not subjected to flexing.

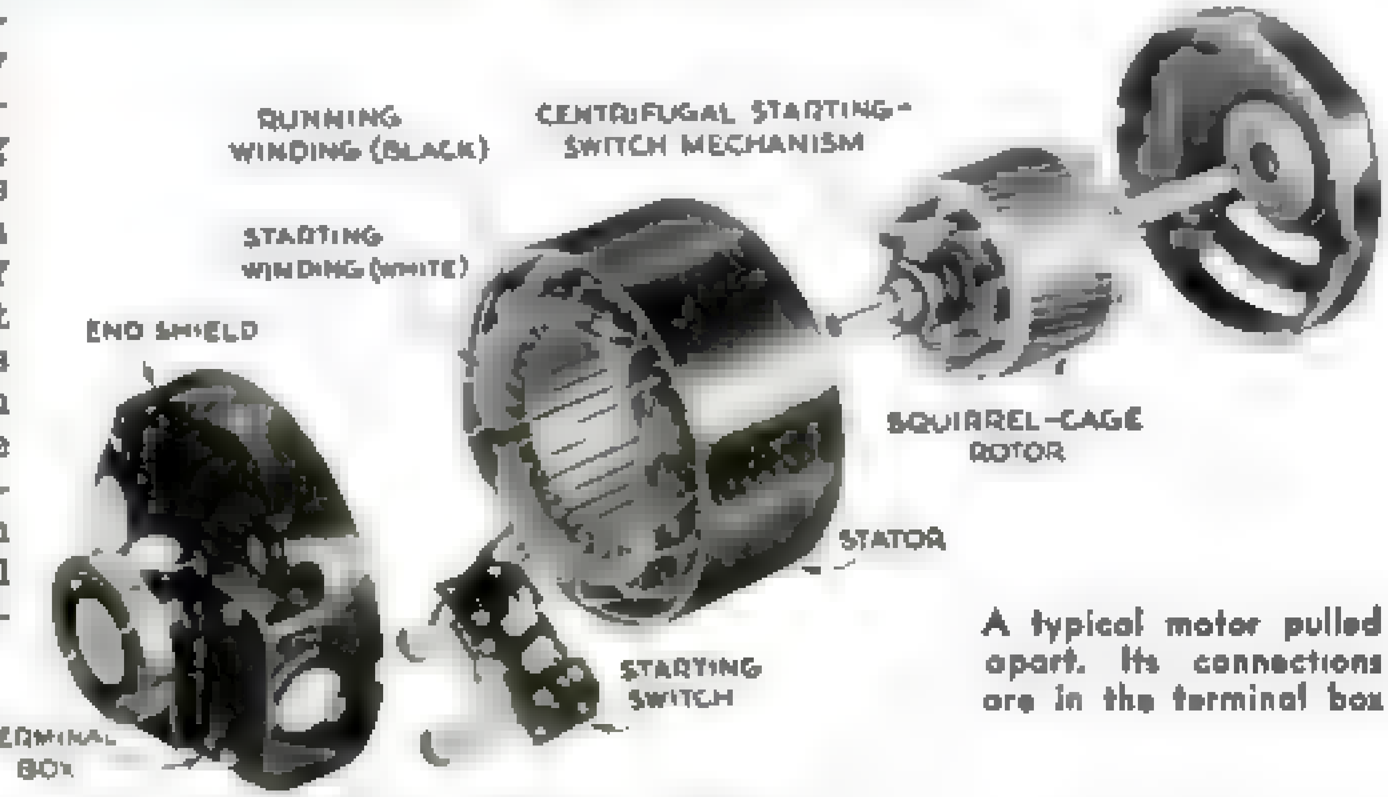
Electric-appliance cords contain rubber. Keep the kinks out of them. Don't wind the vacuum-cleaner cord too tightly around the two hooks on the handle.



Reversing Small A.C. Motors

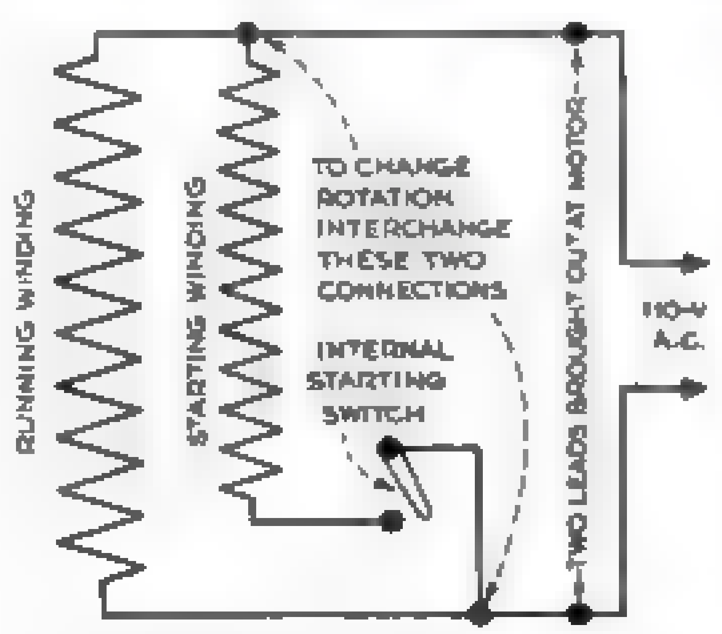
SPLIT-PHASE A.C. motors are so universally used on power tools, refrigerators, washing machines, and other household equipment that the home mechanic is sure to be faced sooner or later with the problem of reversing one in some installation. It is worth remembering that any motor can be "reversed" by turning it end for end. This is a simple solution when both ends of the shaft project from the motor, as the pulley can then be transferred to the opposite end if necessary. However, in many cases this will prove to be impracticable because only one end of the shaft projects from the housing, and it then becomes necessary to reverse the direction of rotation itself in order to accomplish the mechanic's purpose.

All split-phase motors have a starting winding separate from the running winding, of smaller wire and higher resistance. The current therefore differs in phase in these windings, which are so placed as to create a rotating field that starts the rotor in motion. Once it attains speed, an automatic switch cuts out the starting winding, but the single-phase oscillating field keeps the motor running in the direction in which it has been started. Reversing the relative connections between the two windings will reverse the phase lead and therefore the direction of rotation. On this and the facing page are given directions for interchanging these connections on several split-phase motors having different types of terminals, but the principle involved remains the same for all.



A typical motor pulled apart. Its connections are in the terminal box

REVERSING TWO-TERMINAL MOTOR [ELECTRICAL]



CHANGING DIRECTION OF ROTATION OF SPLIT-PHASE MOTOR WITH TWO EXTERNAL LEADS

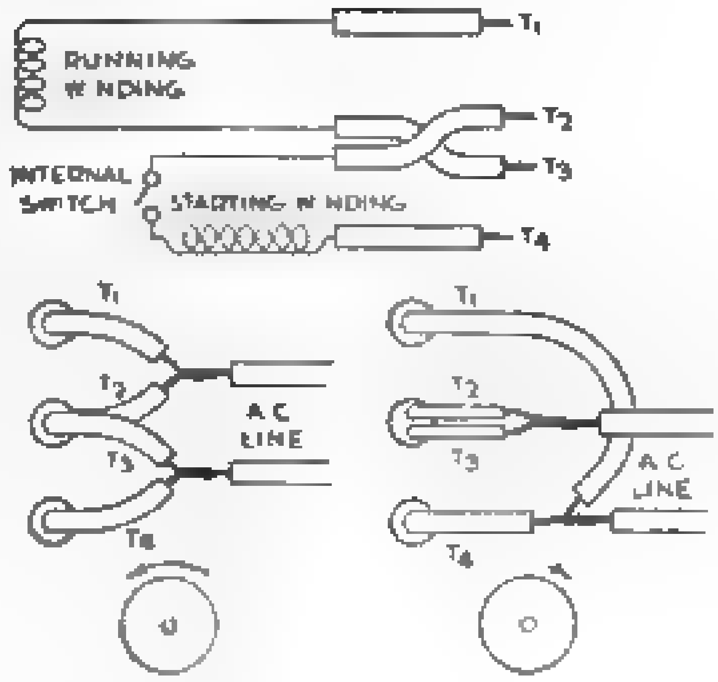
Small split-phase motors are often provided with only two outside terminals. To reverse such a motor, take off the end bell and examine the internal leads to determine how the starting and running windings are connected. The starting winding can usually be identified because it is of smaller wire. Interchange the relative connections between the two windings; that is, reverse the position in which they are connected in parallel. The drawing shows how this may be done. The motor will then run in the opposite direction.

POPULAR SCIENCE MONTHLY SHOP DATA

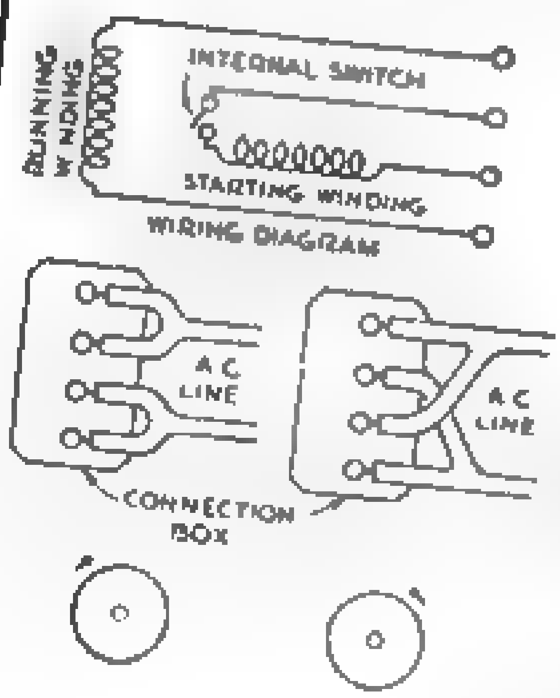
REVERSING THREE-TERMINAL MOTOR [ELECTRICAL]

Some split-phase motors have four leads emerging from three holes in the frame, two of these leads passing through the middle hole. To reverse such a motor, change the connections as shown in the diagram. The direction of rotation is marked as seen from the pulley end of the motor shaft. Be sure to solder all joints.

Although the markings T1, T2, and so on have been adopted as standard, other designations are still in use. For example, the main-winding leads may be marked M1 and M2, and the starting-winding leads S1 and S2. The wiring diagram shows how the leads are connected internally.



REVERSING FOUR-TERMINAL MOTOR [ELECTRICAL]



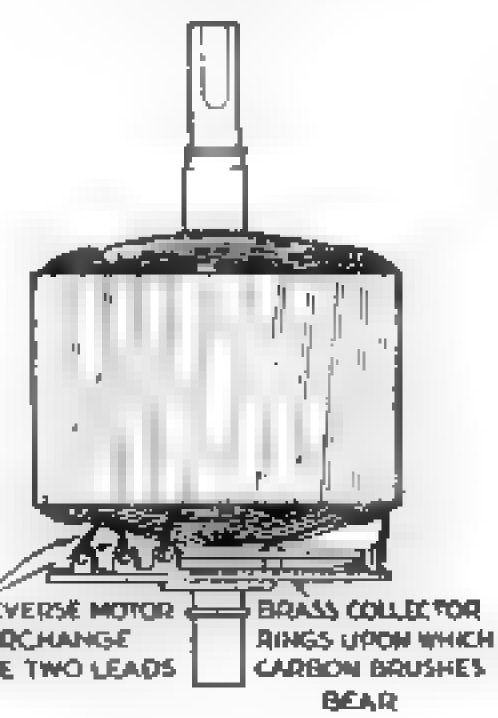
In split-phase motors having four leads or terminal posts, rotation is reversed by interchanging the connections of the two middle terminals to the A.C. line, as shown in the accompanying diagram. In effect, of course, this reverses the relative connections of the starting and running windings, as is shown in the wiring diagram. The direction of rotation is in each case marked as seen from the pulley end of the shaft.

Connections to pigtail wires should be soldered. Insert the control switch in series with the power line.

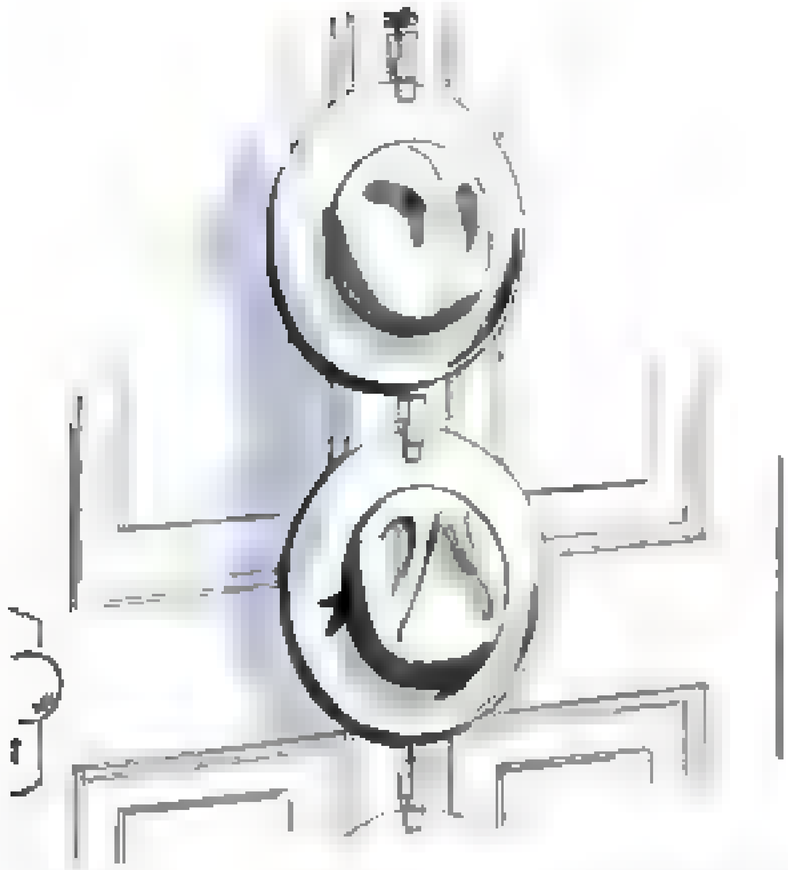
REVERSING ROTATING-FIELD MOTOR [ELECTRICAL]

In the rotating-field type of split-phase motor the starting and running windings are found on the rotor, and are energized through carbon brushes bearing against brass rings. The stator has no winding, but only copper bars laid in the slots, like the rotors of conventional split-phase motors.

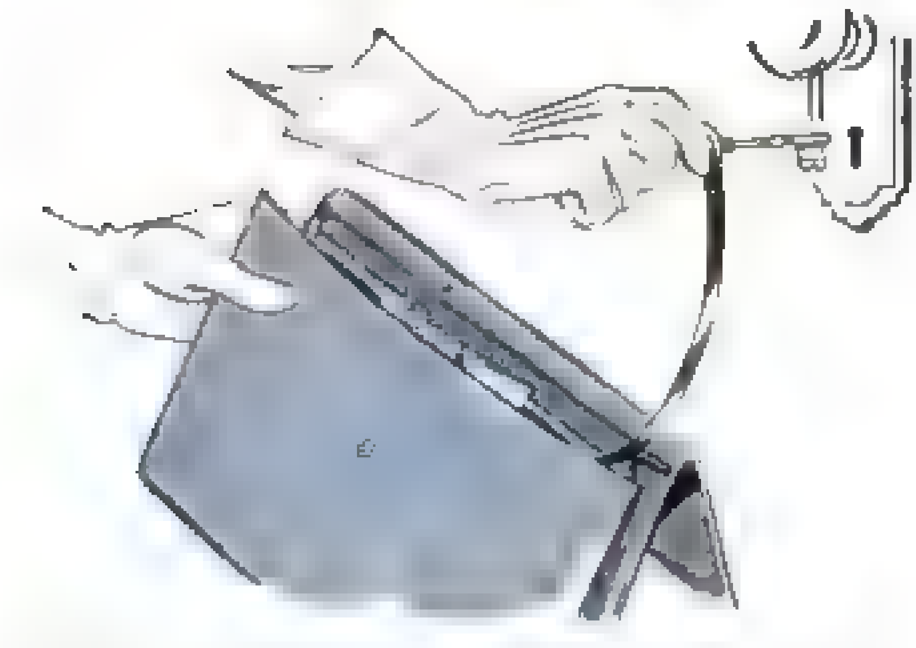
To reverse the direction of rotation of a rotating-field motor, remove the armature and compare it with the accompanying drawing. It will be seen that there are four leads connected to terminal screws as shown. Interchange the two leads marked on the drawing and reassemble the motor.



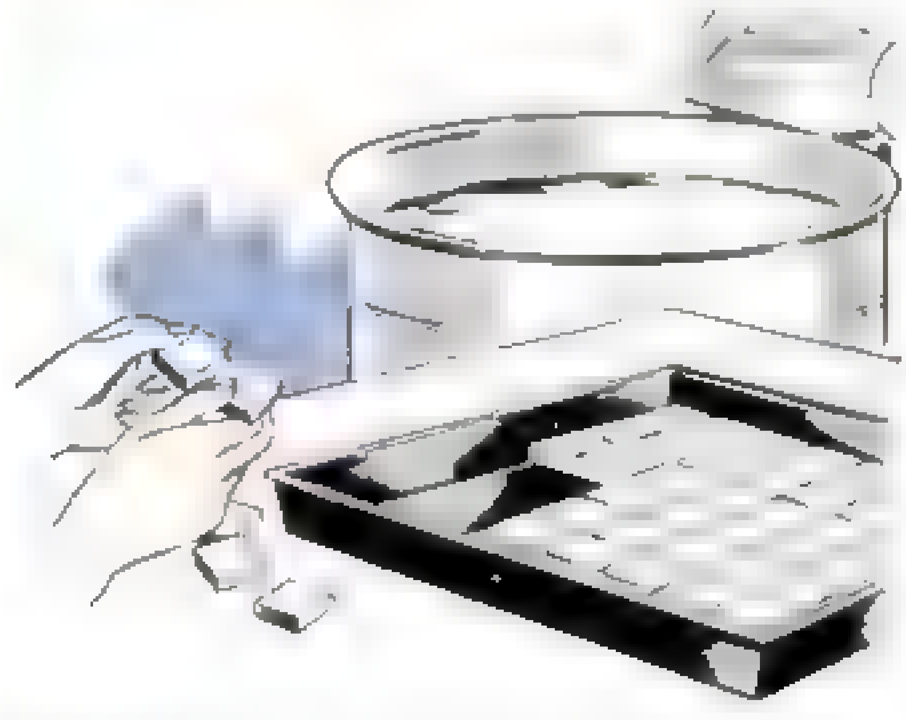
KEEPING



Straw hats too awkward to hang on ordinary hooks will stay in place when held by clothespins. Tie a heavy cord through the coils of several pins and fasten it to the back of a little-used door

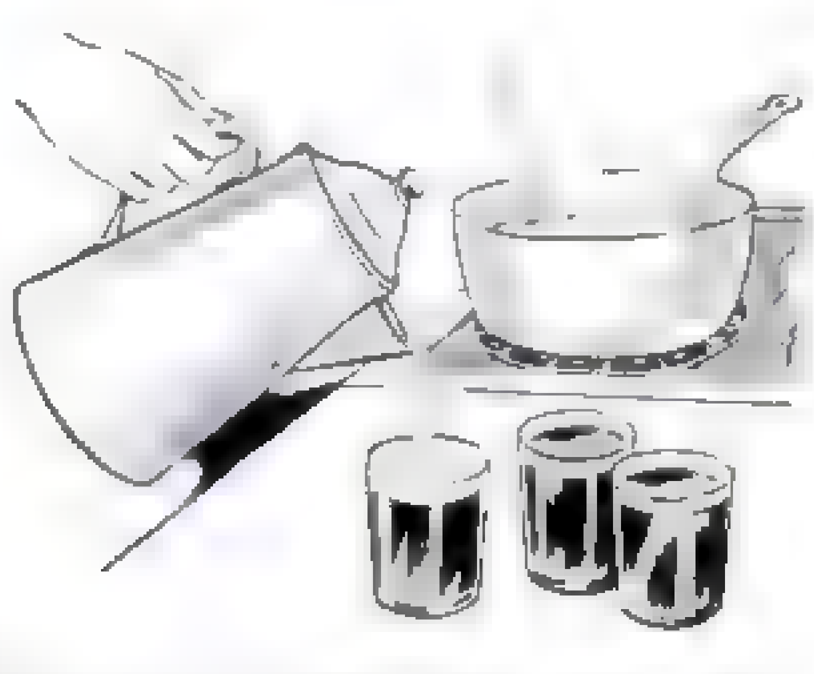


For the woman who has difficulty in finding a key among articles in a handbag, a ribbon tied to the key and pinned to the bag's lining will be a boon



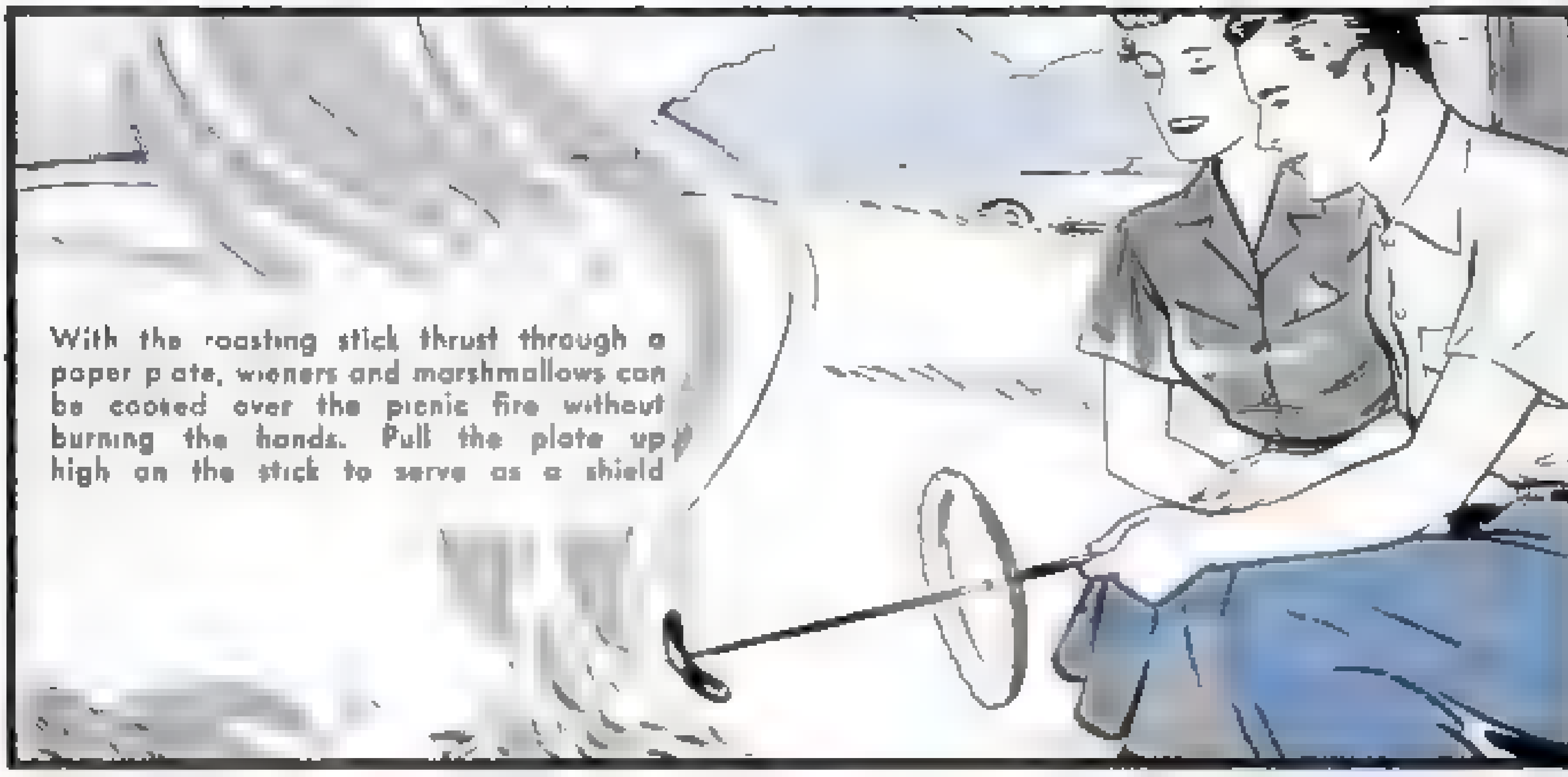
Convenient squares of water softener that save much washing soap are made by melting together trisodium phosphate, sal soda, and paraffin in equal parts and pouring 1/4" deep in a pan. With a knife, mark off 1" squares for use as needed

Large oiled-silk food covers put on the wheels of a baby carriage when it is brought inside from a muddy street will help to keep the floors clean

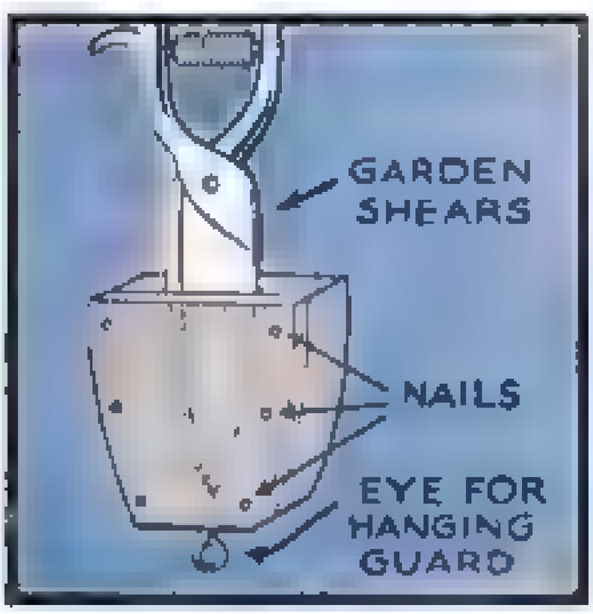


Paraffin for sealing preserves can be poured without spilling from a small coffee pot kept for the purpose. The lid protects the left-over paraffin

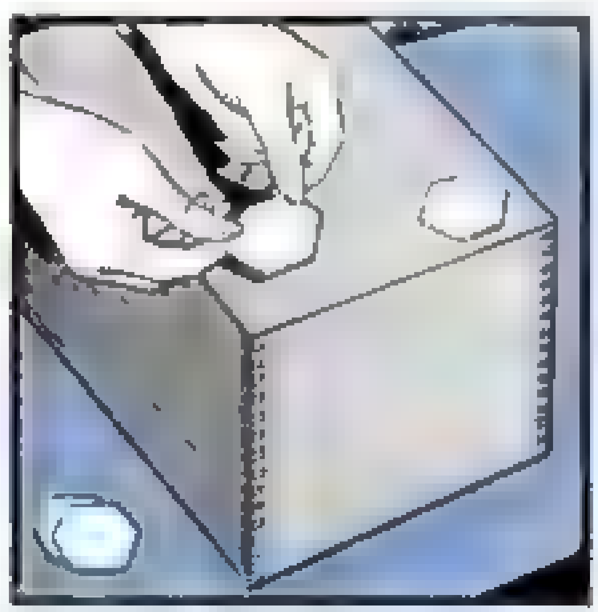
THE HOME SHIPSHAPE



With the roasting stick thrust through a paper plate, wieners and marshmallows can be cooked over the picnic fire without burning the hands. Pull the plate up high on the stick to serve as a shield

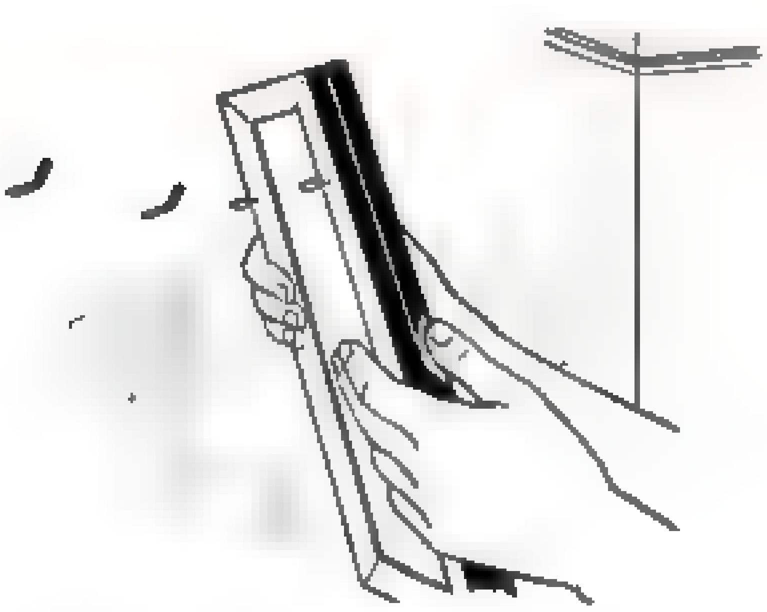


Spring-clip shears having no catch may be kept in a sheath hollowed from soft wood and covered with plywood as shown

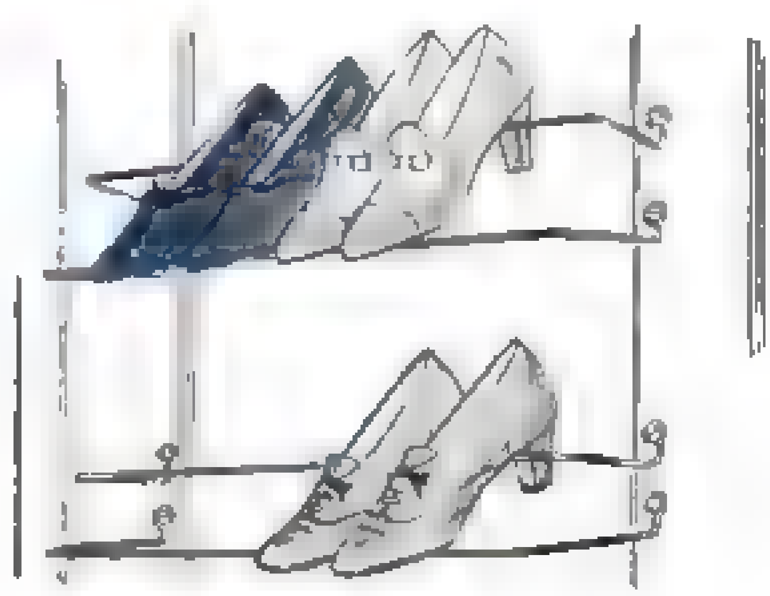


Tiny cosmetic pads glued on book ends, jewel boxes, and the like make inexpensive nonscratching feet for use on polished tables

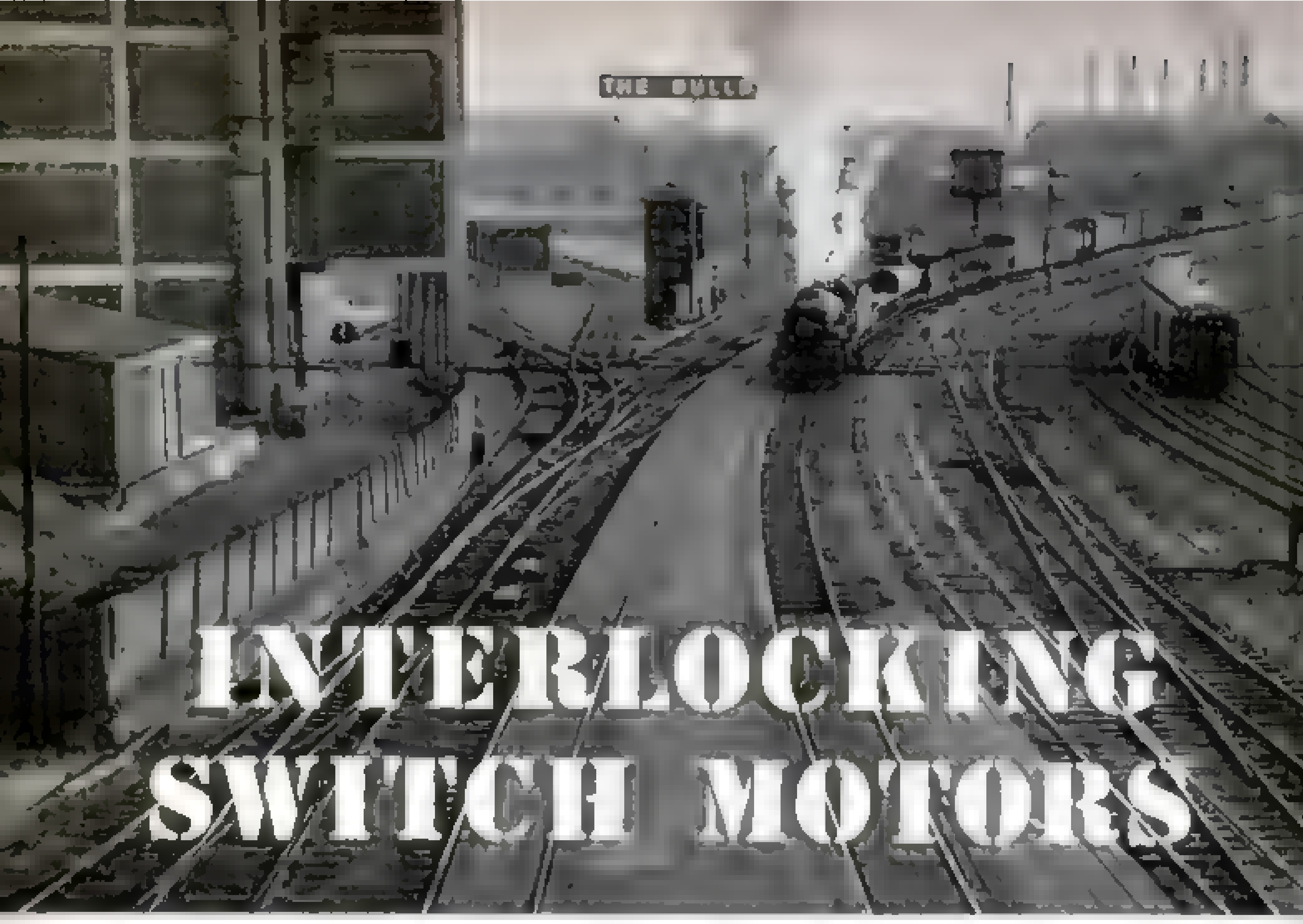
Pressing the bottom of a full paint, syrup, or similar can on an upturned spool will usually force open a stubborn friction lid



Pictures may be hung by screw eyes on slanting brads without using wire. Press frame and eyes against the wall to mark the spot for the brads



Wire coat hangers, bent to shape as above, form closet-door shoe racks. Use two for each rack. Extend the upper 3" from the door, the lower 8"



INTERLOCKING SWITCH MOTORS

By DAVID MARSHALL

Author of Model Railroad Engineering

RAILWAY switch controls are today incorporated in signal engineering. Signals can, of course, exist apart from switches, but it is a basic principle that switches cannot exist apart from signals. Therefore, the fundamental rule is that switch motors must be of the same size and type as signal motors, since both may have to operate on the same electrical circuit.

SWITCH MOTOR. First of the requirements of a good switch motor is that, after throwing the points either way, it shall continue to hold them in position, and prevent their drifting open, which would, of course, result in wrecks. To accomplish this, the orthodox design makes use of an offset slot shaped somewhat like an *S*.

In Fig. 1, we have two doorbell magnets such as we used for signal relays. An iron plate *A* is free to slide toward whichever magnet you energize, but cannot move sideways. In its offset slot slides a pin fastened in the transverse bar *B*, which can move only at right angles to *A*.

This slot-and-pin arrangement transfers the motion of *A* to *B* on a line perpendicular to that of *A*, but once the pin is in the straight portion at either end of the slot, *B* cannot transfer motion to *A* and is therefore locked. As the transverse bar is connected with a tie rod to the switch points, No. 1 magnet, for example, will open the switch and No. 2 magnet will close it. The pin and slot lock the points rigidly.

SWITCH POSITIONS. Since terminology is the essence of much that follows, we must note here (Fig. 2) that a switch is closed when the points are in position to form a straight route, or the straighter of the two routes. A switch is open when the points cause a train to follow the diverging or the more diverging route.

SWITCHES IN ACTION. In Fig. 3 we recur to the double-tracked junction we signaled in a preceding article. Each of the four routes 1, 2, 3, and 4 is protected by a signal of the same number. Although signals 2 and 3 are on the same mast, they remain quite distinct, the higher one guarding the straight route, and the lower one, the diverging route.

But here we have added something new to the layout and have identified the two switches as *A* and *B*. Each switch motor has a No. 1 coil and a No. 2 coil, making four coils in all, to be identified henceforth as A1, A2, B1, and B2. Significantly, we also have four signals.

Why significantly? Because to establish the No. 1 route is not simply a matter of

clearing the No. 1 signal; it is also necessary to open switch *A*. Now, you *clear* No. 1 by energizing its relay. And you can do both jobs at once by connecting the A1 switch magnet to the signal circuit in parallel with No. 1 signal relay.

Likewise coil A2 is hooked up in parallel with signal relay No. 4, B1 in parallel with relay No. 2, and B2 in parallel with relay No. 3. Thus switch controls disappear entirely, absorbed into the signal circuits in such a way as to remove all possibility of a conflict that might cause an accident.

MANUAL SWITCH-AND-SIGNAL MACHINE. In Fig. 3, it will be noted, three pairs of routes are mutually acceptable. Routes 2 and 4 clearly foul each other; but 1 and 2 are acceptable to each other, 3 and 4 are likewise acceptable, and so are 1 and 3.

To take care of this situation, three main levers are required in addition to the usual four route levers, each of which now controls a switch motor as well as a signal relay (Fig. 4). The route levers need no explanation—they are single-pole single-throw switches, and each corresponds to a given signal or, as we should now say, to a given route, since to throw a lever now is to energize a switch magnet as well as to operate a signal. The main levers, on the other hand, are single-pole double-throw switches, and must be closed in proper combination to set up any two mutually acceptable routes.

Thus, to establish route 3, main lever *B* must be closed to the right and route lever No. 3 closed. If in addition to route 3, route 4 also is to be established, main lever *C* must also be closed to the right before route lever No. 4 will close the switch and clear No. 4 signal. However, if route 1 instead of route 4 is to be established together with route 3, main lever *C* must be closed to the left instead of the right and the third lever, main lever *A*, closed to the right.

All this is clearly set forth in Fig. 4, which will be recognized as the diagram of an interlocking machine. The wiring shown enables you both to set the signals and throw the switches to any two acceptable routes desired, but makes it impossible for you at any one time to clear routes that foul each other. The wiring required to *clear* two conflicting signals simultaneously simply is not there.

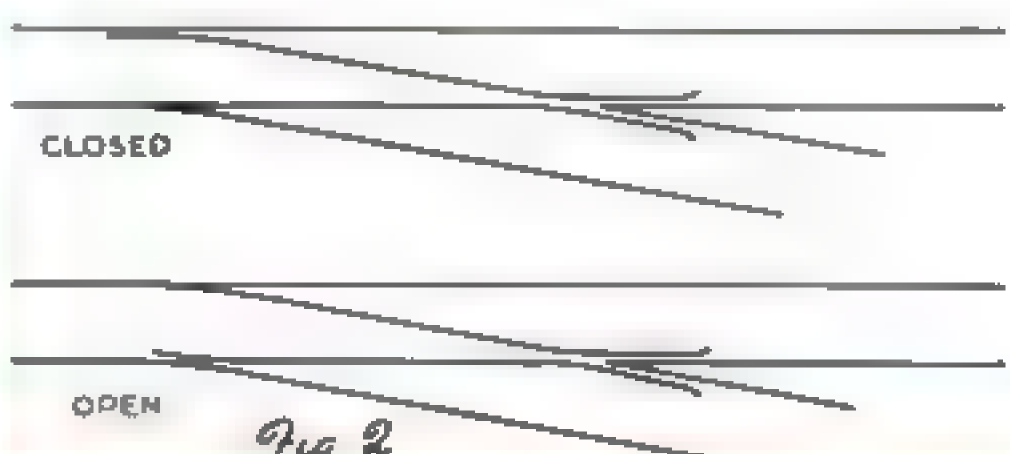


Fig 2

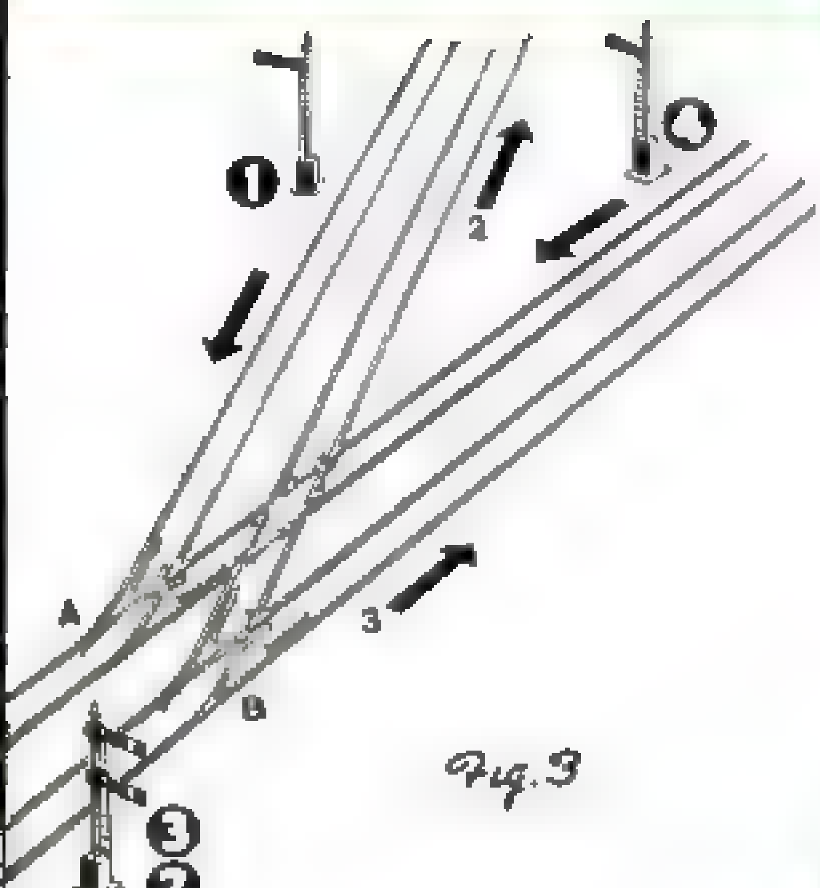


Fig. 3

BLACKOUT RECEIVER

Battery-Operated Set with Only Two Tubes Costs Little to Run

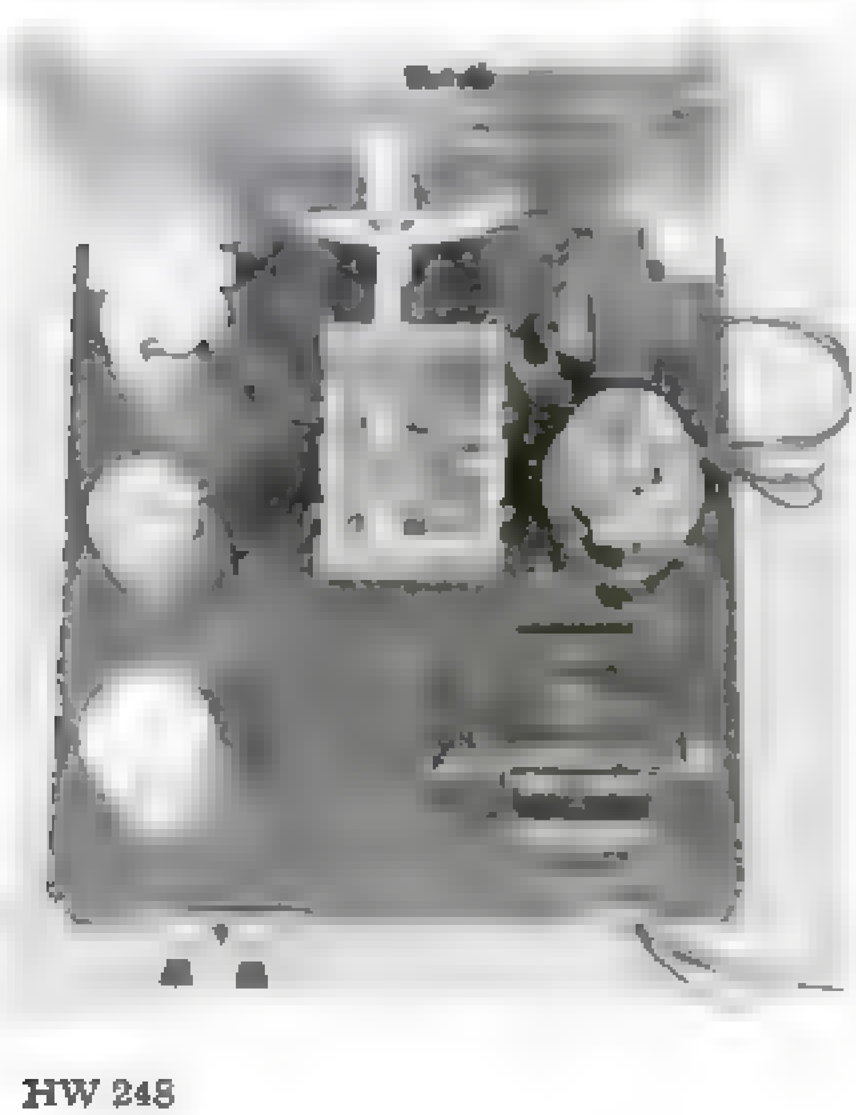
By ARTHUR C. MILLER

This is a back view of the cabinet shown above at right. The 2" by 7" by 7" chassis is on the left, and the "A" and "B" batteries are seen at the right

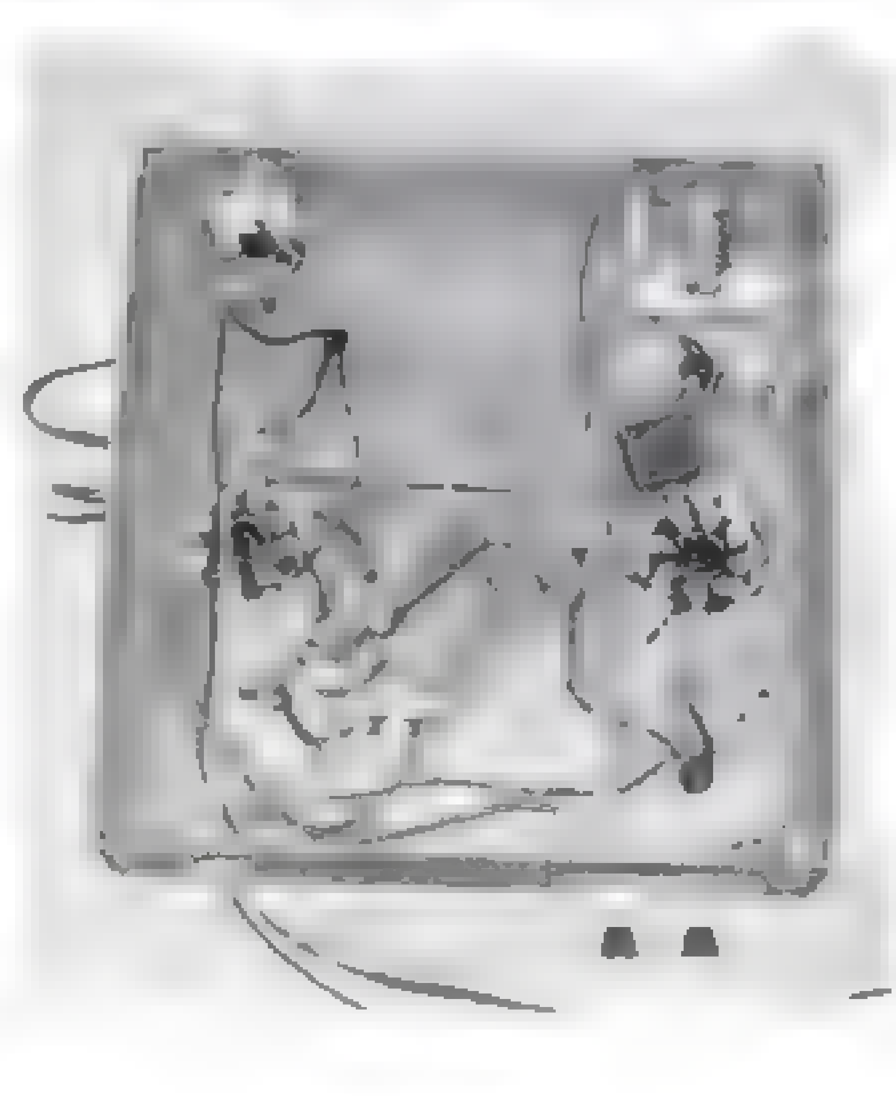
ALTHOUGH two tubes usually are needed just for the push-pull stage in a receiver, here is one with only two tubes multiplied into an RF stage, a high-mu detector stage, and a push-pull output stage using two pentodes! Powered by dry batteries, this receiver is especially useful in the home in case of a blackout and is extremely economical to operate.

The 3A8-GT tube is a combination RF pentode and a high-mu triode detector, while the 1E7-G tube is a twin pentode. The filaments of the 3A8-GT are connected in series (2.8 volts), and operated straight off a 3-volt "A" supply without a filament re-

Below, a top view of the chassis. Note the small push-pull output transformer behind dial at the left



Bottom view of the receiver chassis. The wiring is simple and should be an easy job even for a beginner



sistor. However, the filaments of the 1E7-G draw 2 volts at .24 amperes so that it is necessary to insert an 8-ohm semivariable resistor in series with the filament prong (No. 7) of the tube and the chassis.

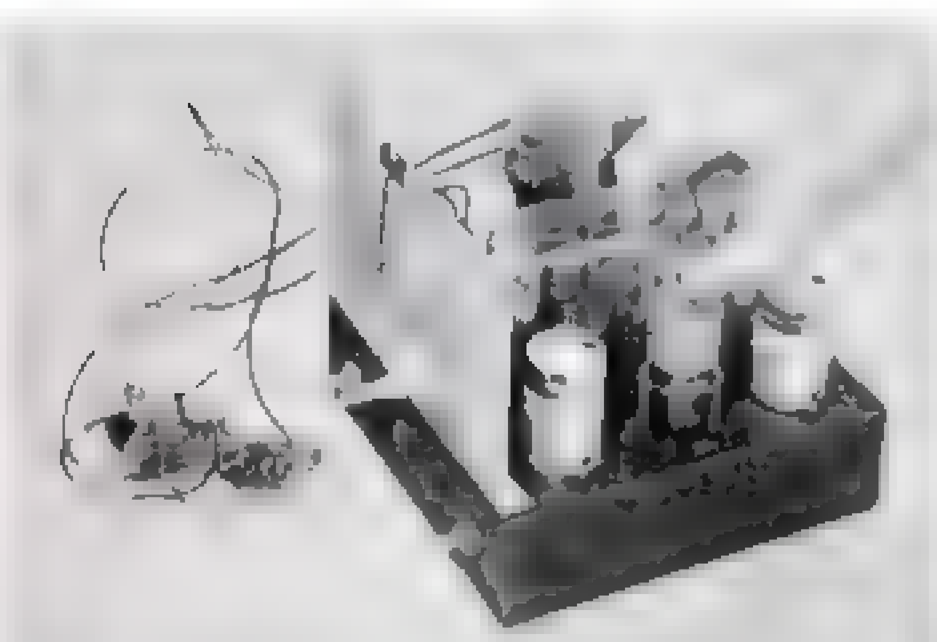
No "C" battery is required, the necessary voltage being obtained through a resistor placed in the "C" return lead of the push-pull audio transformer. For best results and greatest volume the plate voltage ("B"-battery supply) should be increased from the usual 90 to 135, which means the use of three instead of two 45-volt "B" batteries. However, excellent results can be obtained with just two 45-volt "B" batteries. No ground is necessary.

A 250,000-ohm variable resistor in the screen circuit of the 3A8-GT's pentode controls the volume. Tuning is accomplished by means of a two-gang, .00036-mfd. tuning condenser. On the right side facing the cabinet is a third control—a .0001-mfd. variable condenser connected across the antenna tuning condenser. As it is not always possible to obtain perfect tracking across the entire broadcast band with a battery receiver, this additional trimmer condenser is used to balance the RF and detector stages. It does not have to be set for each station—just portions of the broadcast band. The small trimmer condenser already on the antenna tuning condenser is not used and is left at minimum capacity.

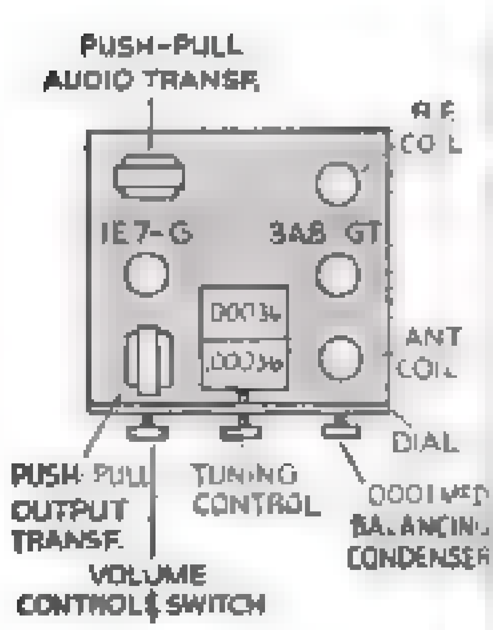
The cabinet measures 8½" by 9½" by 15½" to accommodate the batteries and a six-inch, permanent-magnet speaker. The chassis is 2" high and 7" square.

LIST OF PARTS

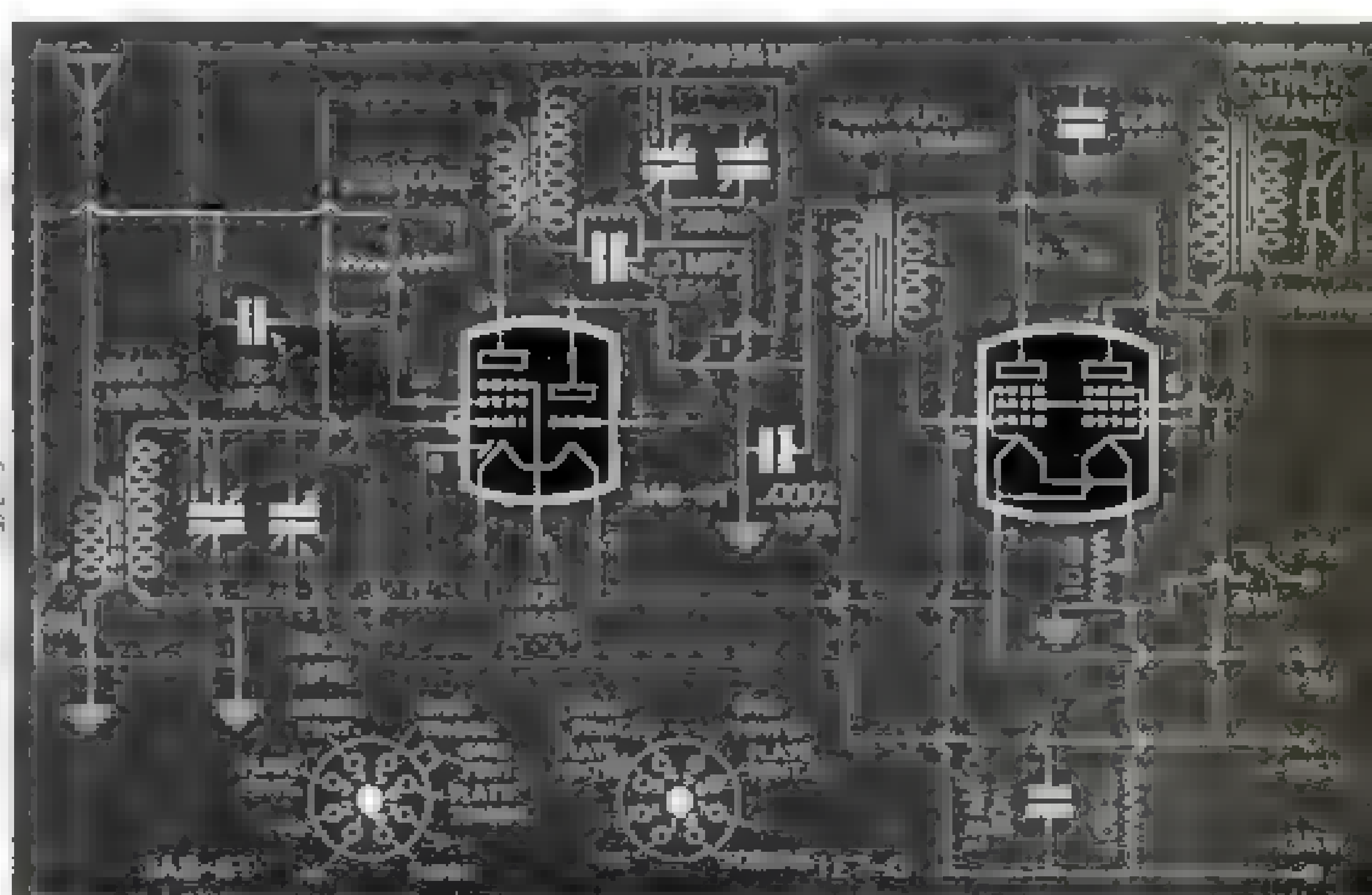
- Cabinet, 8½" by 9½" by 15½".
- Black wrinkle chassis.
- PM speaker, 6".
- Slide-rule dial
- Push-pull output transformer.
- Push-pull interstage transformer
- Tuning condenser, 2-gang, .00036 mfd.
- Iron-core shielded antenna coil.
- Iron-core shielded RF coil.
- Variable condenser, .0001 mfd.
- Tubes: 3A8-GT and 1E7-G
- Octal sockets.
- Variable resistor, 250,000 ohm.
- Coverplate switch, 3-position.
- Paper tubular condenser, .05 mfd
- Electrolytic condensers, 25 mfd., 50 volt, and 10 mfd., 25 volt.
- Semivariable resistor, 10 watt, 8 ohm
- Antenna-ground binding post.
- Carbon resistor, 300 ohm, ½ watt.
- Mica condenser, .0002 mfd.
- Mica condenser, .001 mfd



Left, view of chassis showing the 3A8-GT tube being placed in its socket. At its left and right are the antenna and RF coils. Wiring is diagrammed below

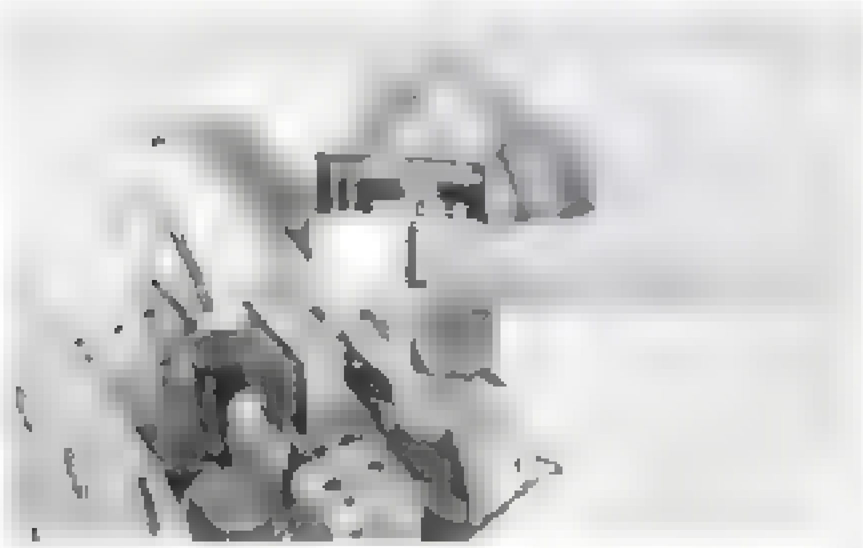


The layout of the various parts of the receiver is shown in the drawing above, actually a top view of the chassis. Follow it carefully in building the set



Servicing Your Radio—PART 5

DIAL troubles often can be corrected easily. Many of the older AC-DC midgets have a direct-drive dial, in which the tuning knob is mounted right on the shaft of the tuning condenser. The only thing that can go wrong with this type is a loosening of the knob, which is remedied by tightening the set screw. Slightly more complicated are the friction drives using a belt or cord. The photographs below show various troubles encountered on these sets, and how they can be eliminated.

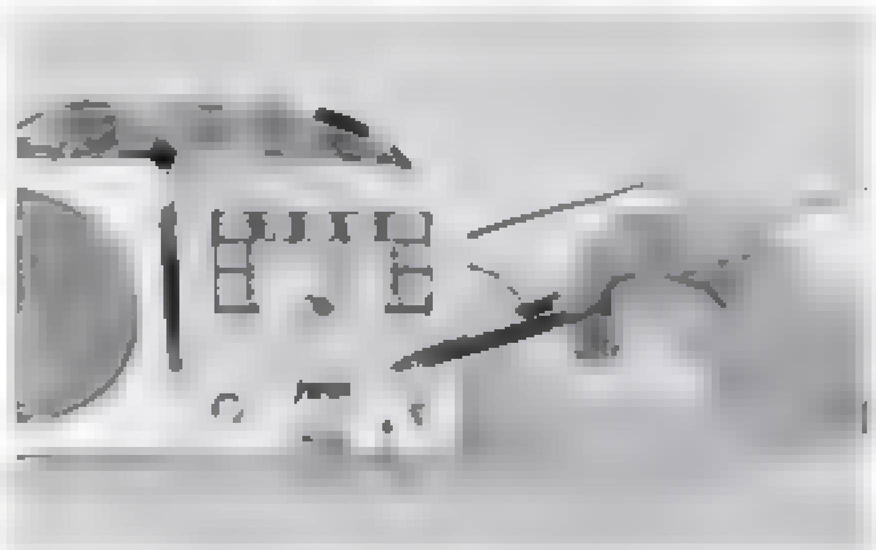


A squeaky slide-rule dial is remedied easily by a little oil on the wheels over which the dial cord runs. Oil very lightly with a light lubricant, being careful not to get any oil on the cord itself

If the pointer is not calibrated properly with the frequency marks on the dial, it is an easy matter to move it to the correct position. Once it is set properly for one station, it will be correct for all

A slipping belt, when it is not too serious, can be remedied by applying a special wax obtainable in stick form. Rubbed lightly on the belt as shown, it usually is found to give a smoother-working dial

In some friction-drive dials, the cord is kept taut by a spring behind the dial plate as shown above. To tighten the cord, it is necessary only to remove the spring and make another knot in the drive cord

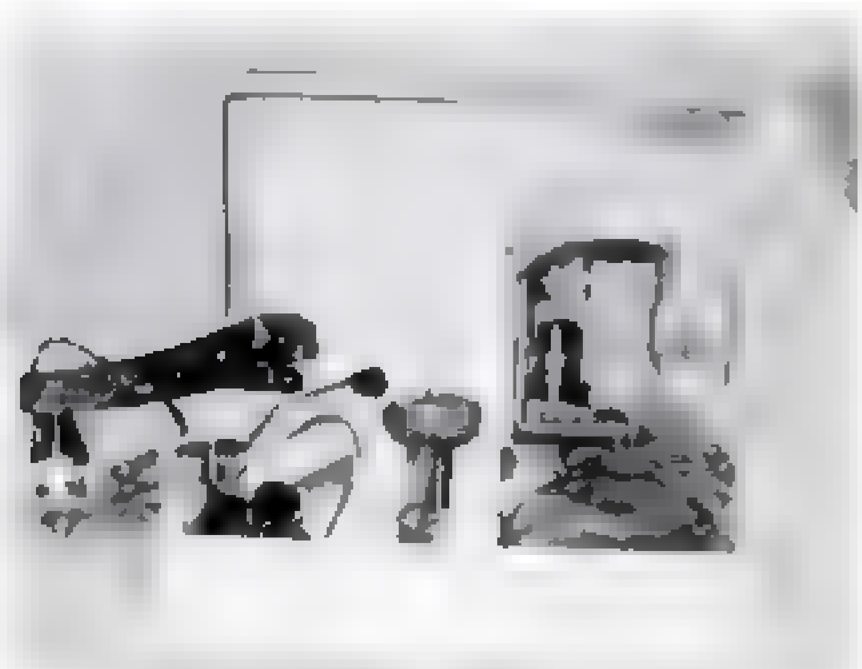


To get at a spring behind the dial plate as shown in the photograph above, it is necessary to take off the plate. To do this, loosen the two hex nuts indicated by the pencil in this illustration

If moving plates touch fixed plates in a tuning condenser, loud static is produced whenever the dial is touched. On most condensers this can be corrected by adjusting with a screw and lock nut

Radio Ideas

A MOBILE PICK-UP specially designed for use in sound trucks, planes, trains, and other unsteady locations has its tone arm mechanically counterbalanced so that it will track on records without jumping the groove even when in a vertical position. The photograph at the right was taken with the machine in actual operation. The head is hinged so that it can be tilted upward for quick changing of needles. Equipment includes a two-foot shielded cable.



EVERYTHING YOU NEED in the way of special equipment for home recording is included in a kit recently put out by a leading radio manufacturer. It contains a microphone, cutting head complete with drive mechanism, control amplifier box, cutting-arm rest and mounting screw, recording needle, templates, and speaker-adapter plugs. When used with a standard radio-phonograph combination, the apparatus in the kit makes it possible to do home recording and also to record important speeches, favorite programs, and musical performances from the radio to which it is attached. This is one of the first complete home-recording kits to be offered to the public.

ELECTROLYTIC CONDENSERS incased in shells of black plastic are one manufacturer's solution to the problem created by wartime priorities on aluminum. Until the present emergency, such condensers used in the filtering circuits of receivers have always had shells of the lightweight metal. The new plastic-shell condenser shown below even has plastic threading at the bottom for attaching it to the chassis. It is available in all popular types, including the double electrolytics such as the 8+8-mfd., 450-volt.

PLASTIC TUBING for electrical insulation, now being used extensively in the aviation industry, should find wide application in the field of radio. The new sleeve insulation has high dielectric strength, great resistance to temperature variations, and a moisture-absorption factor of less than one half of one percent in 24 hours of water immersion. It is available in a variety of colors in standard ASTM diameters of 36-inch length, or in continuous coils in minimum lengths of 25 feet.

Mystifying Tricks for the Dinner Table

IT'S easy—when you know how—to baffle your friends with entertaining tricks at the dinner table. A scrap of paper, the salt shaker or sugar bowl, an egg, a few toothpicks, and a little vinegar and baking soda are all you need to perform the half dozen stunts that are described here.

When you try making a self-supporting structure of three toothpicks, as shown on the opposite page, you'll be surprised to find how many wrong ways there are.

The trick of smothering the match succeeds because the carbon dioxide gas, being heavier than air, will stay in an uncovered tumbler until blown out. If you avoid drafts, you can make the stunt more mystifying by pouring the invisible gas like water from one glass to another.

SEEING THROUGH YOUR HAND. Hold a tube of paper as at left, with both eyes open—one looking through the tube, and the other at your hand. Though you know it can't be so, you see a hole in your hand, and distant objects beyond. The phenomenon resembles a double exposure on a camera film. Your mind superimposes what the left and right eyes see, and is tricked into misinterpreting the result when the twin images don't match. By practice, users of "one-eyed" laboratory instruments, such as microscopes, learn to disregard what the unused eye sees and need not bother to close it while looking through the instrument.

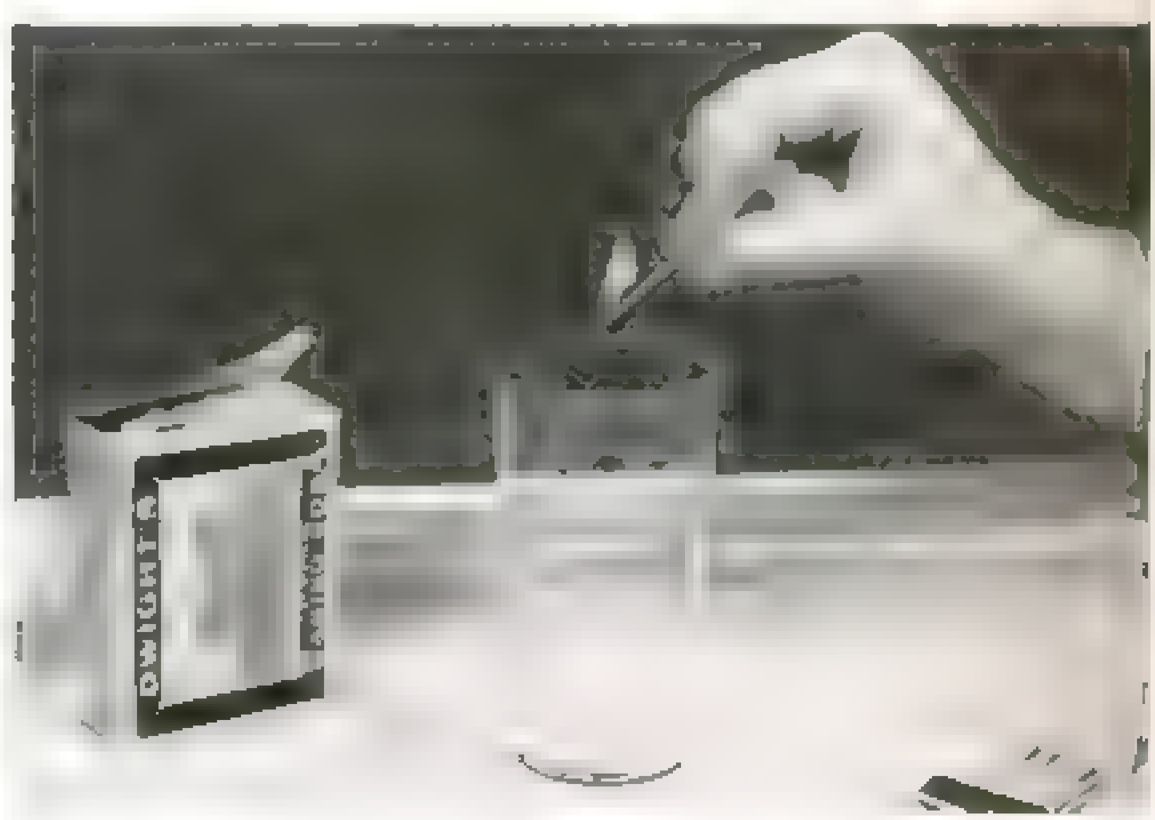
WHEN A FULL GLASS ISN'T FULL. Challenge others to add something of considerable bulk to a glass of water, without making it overflow. When they give up, reach for the sugar bowl and put in a little sugar at a time, as shown above. You should be able to add nearly an ounce. In dissolving, molecules of sugar appear to fit into open spaces among molecules of water, and therefore add only slightly to its bulk.

MAGIC TOOTHPICKS. Arrange six or eight toothpicks, radiating from an open space at the center, in a dish of very still water. Dip a napkin in the middle, as above. The toothpicks will rush to it, drawn by water currents responding to capillary attraction. Substitute a corner of a piece of soap for the napkin, and the water will snatch the "magic" toothpicks away from the center, where surface tension has been lessened.

THE RISING EGG. Stump your friends by asking them to make an egg rise to the surface of a glassful of water, without touching it. The stunt is easy. Merely add salt to the water. Heavier than fresh water, the egg stays on the bottom; lighter than strong salt water, it rises and floats as soon as the solution attains the required density. Mineral industries apply a similar flotation principle to separate valuable parts of crushed ore from worthless rock, by adding the whole to a vessel containing a liquid of suitable specific gravity in which the lighter material will float.

SHORT TIMBERS SUPPORT ROOF. Could you frame a sturdy roof for a silo with only three timbers, each one a little more than half as long as the diameter? A tumbler and three toothpicks will serve for a small-scale trial. The correct arrangement, below, will support as considerable a weight as another glass filled with water. Starting from the rim, each toothpick passes *under* the first toothpick it meets, and *over* the second one.

GAS SMOTHERS MATCH FLAME. Show that a match will burn when lowered into a tumbler. Now repeat the test after stirring together, in the bottom of the glass, some bicarbonate of soda, vinegar, and water, and letting the effervescence subside. The match flame promptly goes out Blow hard into the glass, and another match will stay lit. Carbon dioxide gas, from the soda-vinegar mixture, smothered the preceding one



Textile Chemistry

Heavily weighted silk, at left, burns slowly and leaves an ash retaining the form of the original threads. Burned samples above are (top to bottom) cotton, wool, and acetate rayon. Note hard bead on the rayon

By KENNETH M. SWEZEY

"ACID TEST" REVEALS

IS THAT blanket or suit you just bought really 100% wool? Is your tie silk, your handkerchief linen, your hosiery rayon and wool, exactly as advertised? With simple tests in your home laboratory you can in most cases find out.

By flame alone, you can readily identify cotton, wool, silk, and rayon, provided the material is unmixed. Merely hold a lighted match or alcohol flame to the end of a few strands. Cotton and rayon burn quickly with a bright flame, and emit the familiar odor of burning rags or paper. The ash each leaves is a light yellow-gray. Rayon can easily be distinguished from cotton by its silkiness and luster. Acetate rayon burns more rapidly and leaves a hard bead of sealing-wax consistency as an ash.

Silk and wool burn slowly, giving off an odor of burning hair or feathers. They form a knobby, cokelike ash. Heavily weighted silk (silk having its fibers impregnated with

To find out how much wool there is in a cotton-and-wool mixture, make a two-percent solution of sulphuric acid and work a drop of it into the sample

CAN YOU TELL WOOL FROM COTTON, SILK FROM RAYON? HERE ARE SOME SIMPLE FABRIC TESTS

salts of such metals as tin, zinc or lead, to give the material greater weight and better draping qualities) burns with difficulty and leaves an ash which retains the form of the original material.

Linen, kapok, hemp, jute, artificial horsehair, and paper yarns burn with the same characteristics as cotton and rayon. Goat, rabbit, and camel's hair, as well as casein wool, burn like silk and wool. These less common materials may generally be distinguished by their appearance.

Are those "all-wool" trousers really all wool? Snip off a tiny piece and put it in a test tube containing a five-percent solution of sodium hydroxide, or common lye. Boil gently for 10 or 15 minutes. If it is all wool, the material will dissolve completely. If a skeleton of the fabric remains the chances are a hundred to one that that part is cotton.

If you are still in doubt concerning a wool-cotton mixture, give it the "acid test." Mix two drops of concentrated sulphuric acid in 100 drops of water, and put a drop or two on a piece of the cloth, allowing it to sink completely through the material. Next place the sample between several sheets of paper and press with a hot iron. If the material contains cotton, the spot where the acid was placed quickly becomes charred. When you rub the charred spot gently between a thumb and forefinger the cotton will fall away, leaving whatever wool the material contains as a remainder.

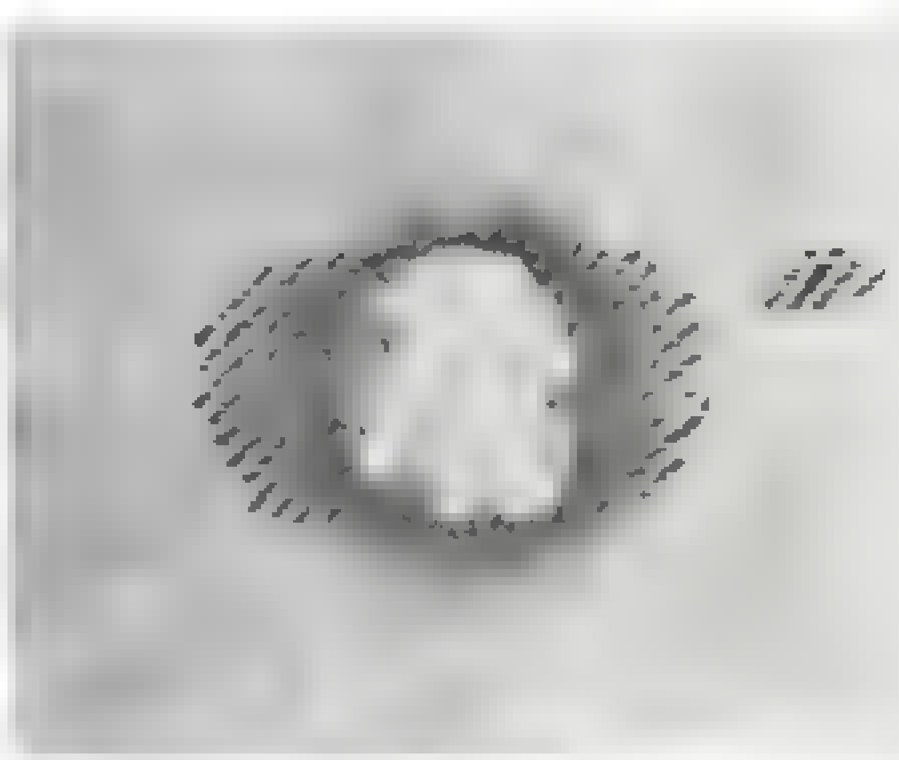
The fact that wool and hair are the only fibers containing enough sulphur to be set free as hydrogen sulphide, makes possible another easy test for checking on these materials. Heat a sample, dry, in a test tube into which you place a piece of filter paper moistened in a solution of lead acetate. If the textile is hair or wool, the hydrogen sulphide driven off gradually turns the paper gray or black—the lead acetate being changed by the gas into dark lead sulphide.

About 90 percent of the world's production of rayon is now made by the viscose process, in which cellulose is dissolved in sodium hydroxide and carbon bisulphide, and brought back into solid form again by treatment in a "regenerating" bath. Acetate rayon, made by treating cotton with acetic acid and acetic anhydride, is more costly than viscose but is less weakened by wetting, and more closely resembles real silk. If the burning test does not prove conclusively the difference between these rayons, drop a sample of material into a little acetone. Acetate rayon quickly dissolves, viscose is unaffected.

If a burning test indicates a sample to be silk or wool, and your eye and touch cannot tell you the difference, put a piece of the sample in concentrated hydrochloric acid for 15 or 20 minutes. Real wool, hairs, or

JUST HOW MUCH "PART WOOL" REALLY MEANS

Now put the cloth between padding made of several sheets of paper and press it with a hot iron until the cotton part has been thoroughly charred



When you rub the charred part gently between your fingers, the cotton fibers will fall away, leaving the wool. Now you can tell how much of it is wool

Wool or hair in a fabric will give off hydrogen sulphide when it is heated, blackening a piece of filter paper that has been moistened with a solution of lead acetate and held in the tube

Cotton and linen are easily distinguished by tearing a piece quickly. Cotton tears smoothly, leaving short, uniform fibers as shown above. Linen tears with greater difficulty and leaves fiber ends of irregular length. Another test is to dye a sample with methylene blue

casein wool will not dissolve. Silk dissolves. Casein wool may be distinguished from natural wool by soaking a sample in a 20-percent solution of sodium hydroxide, at 30 degrees C., for three hours. You will find that natural wools will dissolve, while the casein wool will not

Linen can be distinguished from cotton by tearing a piece of the material rapidly. Cotton generally tears smoothly, leaving the ends of the fibers short and uniform. Linen tears with greater difficulty, leaving fiber ends of irregular length.

Cotton and linen may also be differentiated by dyeing samples in a solution of methylene blue, and then washing with cold water. Linen absorbs this dye much more strongly than does cotton.

TESTS FOR IDENTIFYING COMMON TEXTILE MATERIALS

	ANIMAL FIBERS		VEGETABLE FIBERS		
Reagent	Wool	Silk	Cotton	Viscose Rayon	Acetate Rayon
Burning	Burns Slowly With Odor of Burning Hair		Burns Rapidly With Odor of Burning Paper		Burns Rapidly and Forms Bead
Lye, 5% Sol.	Dissolves in Hot Solution		Insoluble		Fibers Swell
Sulphuric Acid, 2%	Unaffected		Chars When Heated		
Nitric Acid	Turns Yellow, Insoluble	Turns Yellow, Dissolves	Unaffected	Dissolves Rapidly Turns Pale Yellow	
Acetone				Unaffected	Dissolves Rapidly
Conc. Hydrochloric Acid	Unaffected	Dissolves	Unaffected	Dissolves Slowly	Dissolves

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TO SAVE GASOLINE • KEEP YOUR SPARK PLUGS CLEAN

Explosives for the War

(Continued from page 76)

but a tendency to leave large quantities of solid residue after discharge. At the same time the high temperature of combustion causes rapid erosion of the barrel.

Smokeless powder, which largely obviates these difficulties, is a form of nitrocellulose or guncotton. When compressed into blocks, nitrocellulose may be used as a high explosive in submarine mines, torpedoes, etc. In the form of grains or pieces it is smokeless powder. The manufacturing process requires extremely close chemical control. The raw cotton is purified, dried, and nitrated by immersion in a mixture of nitric and sulphuric acids. After nitration it is washed, again purified, dehydrated, mixed with alcohol and ether, pressed into a dough, and forced through dies to make a macaroni-like cord which, after drying, may be cut into short lengths or shredded to make perforated cylinders or flakes of the right size. This sketches the process only in the barest outline; actually it is a lengthy, complicated, and delicate affair and requires enormous amounts of raw materials.

The high explosive loaded into shells as a bursting charge must not be too sensitive or the shell will explode in the gun instead of on the target. A practical shell explosive, insensitive enough to withstand the shock of propulsion without exploding, powerful enough to do maximum damage when it lands, may be made of various nitrated coal-tar derivatives. One which still has considerable importance is trinitrophenol, or picric acid. It was very popular in World War I as a shell filler, especially in the navies of the warring countries, both alone and as an ingredient of special mixtures. But they all had a tendency to form sensitive explosive salts with the metal of the shell, causing disastrous premature explosions. It was partly on this account that these materials were replaced by TNT.

TNT, or trinitrotoluene, is derived from toluene, a near relative of benzene, by treatment with nitric acid. To fight the present war to a finish we shall need enormous quantities of nitrogen and toluene, as well as alcohol and other materials. Nitrogen we get from Chile and from the air, principally the latter. Toluene normally comes from the gas and coke industry as a by-product of the decomposition of coal under heat and pressure-cracking. The amounts secured in this way are not great enough for a global war. Fortunately, however, toluene is also obtainable from petroleum, of which we have more than anyone else.

Uncle Sam tells you how to

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Motorcycles for Combat Troops

(Continued from page 121)

new motorcycle to meet the special needs of the Army, engineers were confronted by several problems, probably the most important being cooling and keeping dust and desert sand out of the chain. The latter was solved by eliminating the chain, and all the wear, servicing, and adjusting troubles that went with it, and substituting a shaft drive. Additional cooling was provided by redesigning the engine and extending the cylinders out into the air stream. Dual carburetors have been installed on both the Indian and the Harley-Davidson. Because of the new engine design, the center of gravity is lower in both machines, a feature which makes for easier handling, especially around curves. This, however, has not reduced the road clearance, as might have been expected. On the contrary, the new models provide about two inches more clearance than the conventional types.

On both of the new shaft-driven machines the hand-operated gearshift lever has been eliminated, and a foot-shifter pedal substituted, set on the left side of the frame. The Harley-Davidson has also provided an auxiliary hand-shift lever. There are slight differences in the manner in which the foot-shifter pedal is operated. On the Indian, a shift is made from lower to higher gears by stepping on the rear spool of a rocker lever. To shift to lower gears the toe spool is depressed for each gear change. On the Harley-Davidson, a shift into first gear is accomplished by pressing down on the shifter pedal, while second, third, and fourth gears are reached by lifting the pedal with the toe. To go into lower gears, the rider presses down again. The clutch-operating lever and the hand-brake lever have also been moved, the former to the right handle bar and the latter to the left, and are set in such a way that the rider can operate them without removing his hands from the handlebar grips.

These changes in the location of the gearshift and the clutch lever are among the most important of the new features, since they enable the rider to keep his hands on the handlebars at all times and assure better control of the machine. Other innovations on the new models include a radio-shielded ignition system, four speeds instead of three, a larger storage battery, greater gas-tank capacity, and the relocation of the oil-bath air cleaner, which is now mounted between the engine and the gas tank instead of out on one side. The engine displacement, 45 cubic *(Continued on page 214)*

Gus Has a Visitor

(Continued from page 135)

up. It was a little piece of solder—not round, but sort of lopsided.

"I showed it to the ladies. 'There she is,' I told them. 'That little piece of solder is what's been causin' all your grief. Don't ask me how it got there. Must have been there when the pipe was installed. It's started to cut off the gas, anyhow.'

"'Nonsense!' the big woman sort of snarled at me. 'If it cuts off the gasoline supply, how can the motor run at all?'

"I showed her how the piece of solder was lopsided. 'Being that shape,' I told her, 'it let a little gasoline into the carburetor. But the float bowl drained faster than the gas flowed into it. When the accumulated gas was used up, your engine would stop. But when the engine idled, a little more gas would accumulate in the carburetor. Savvy, lady?'

"She still wouldn't believe me, but after I'd connected up the carburetor again, and the engine had run for five minutes without a miss, she had to admit that I'd fixed whatever was wrong. Then all of a sudden she smiled real pleasant like, and said if I was bound for the town where they were goin' to stay the night, would I have dinner with them!"

"Did you?" Gus asked him.

Sam Chivers rolled himself another cigarette. Then he shook his head. "No, sir, I didn't," he said. "When I find trouble on the desert, I leave it there. You bet!"

Tropics Hold Timber Reserve

FORESTED areas in the Amazon Valley as large as the whole United States are typical of the immense quantities of timber that stand unused in Central and South American forests, according to a report by Prof. Samuel J. Record, of the Yale School of Forestry, before a meeting of the Society of American Foresters. At the same time, there are acute shortages of lumber in Latin America, partly because of imperfect handling and partly because of ignorance of the properties of tropical woods. The average North American's knowledge of South American woods ends with mahogany and cigar-box cedar, Professor Record says. Yet there are dozens of kinds of timber of all weights, densities, and adaptabilities. These might advantageously supplement our own diminished supplies of native woods. Research on tropical woods is being urged as a means of utilizing this vast source of supply.

Motorcycles for Combat Troops

(Continued from page 212)

inches, is the same as on the conventional Army models.

Fundamentally the motorcycle is the result of attempts by early inventors and manufacturers to adapt oil or gasoline engines to the propulsion of bicycles. An English machinist named Lawson built a tricycle in 1880 which was driven by the explosion of gasoline carried in a container strapped to the vehicle, but this machine is said to have been a failure. Most historians agree that the first practicable motorcycle was built by Edward Butler, an Englishman, in 1883, although another two years elapsed before he was able to exhibit it in public.

Butler used an ordinary bicycle frame to which he had attached a third wheel, making a tricycle. His machine was propelled by a small motor with double-acting cylinders coupled to a power wheel, and the fuel used was vapor of benzoline, exploded by an electric spark. Machines somewhat similar to Butler's contraption appeared in France and Germany during the middle and late 1880's, but few improvements were made for more than a decade. Perhaps the most important forward step was the general adaptation of the engines to burn kerosene or gasoline.

The development of the modern motorcycle really began about 1906, when the first of a series of famous races was held in the Isle of Man. The advantages to be gained by winning one of these races caused manufacturers to make many improvements in design and to increase the power of their engines. The punishment which the motorcycles were compelled to undergo in these contests also caused the manufacturers to abandon the twisted leather belt hitherto used for a drive, and to substitute the new two-speed chain drive which had been first introduced about 1902. A few years later the engine was moved from just beneath the seat to a position near the front wheel and low in the frame.

The earliest motorcycles, even the speedy machines of the early part of this century, were started by pushing. A few years before the First World War a clutch was added and the motor started by pedaling. Such improvements as the variable-speed transmission and the kick starter followed soon, and since that time virtually every year has seen a considerable advance in both design and performance.

Cargo Planes for Victory

(Continued from page 70)

planes equipped for general demolition. In that case there will be nothing left in the neighborhood expect bomb craters and wreckage. The Fascists asked for total warfare: that is the way to give it to them.

What is needed is *sustained* bombing. If the Japanese had been in a position to send Mitsubishi 92's, or their equivalent, over Pearl Harbor hour on hour after the initial attack, we might not be in Pearl Harbor today. It is quite conceivable that by now we might have been driven back to Alaska and the west coast of Canada and the United States. If the Germans had had enough heavy and medium bombers to repeat Coventry raids all over England, on Bristol, on Liverpool, on Manchester, on Birmingham, on Sheffield, and to do this night after night and, with the RAF's resources exhausted, day after day, the British bastion might have fallen a year ago. Or if the British had been able to continue bombing Cologne and Essen they could probably have destroyed these cities completely at moderate cost, since the defenses must have been seriously weakened by the first onslaught and subsequent British losses would have been on a lower percentage basis.

In short, the Italian air theoretician Douhet, and our own Billy Mitchell, were perfectly right, but at the beginning of this war no power had the means to put the theory into practice. The fact is that the most savage bombings to date have been on a scale limited by (1) productive power in aircraft; (2) the unprofitable loads carried by the aircraft produced; and (3) by various military factors—in the case of Germany, concentration on air support of ground troops and consequently on production of small dive bombers and fighter planes rather than heavy bombers. Now that American aircraft production is rising toward hitherto unheard-of levels, the lid is off—for us. Within the next year, systematic mass bombings of unprecedented magnitude can be inflicted on German industrial centers. There is nothing secret about it because there is nothing the Germans can do about it. Their productive capacity reached its peak long ago, and, with the Luftwaffe largely tied up on the Eastern front, they cannot reply in kind. They will of course, attempt reprisals, but everything indicates that these will not be on a scale sufficient to cripple Anglo-American attacking power in the West.

Look at the maps of German cities. A

(Continued on page 216)

Cargo Planes for Victory

(Continued from page 215)

rectangle 100 square miles in area will cover all of Berlin that matters in a military way. Fifty square miles is more than enough for Hamburg. Hamburg is about as big as Cologne, considerably bigger than Essen. The actual areas which must be covered are less extensive than 50 or 100 square miles. One is not interested in the cemeteries, truck farms, and residential centers in the outlying districts, but only in the installations which make for war potential—factories, warehouses, power plants, airports, railroad yards, docks, canals, business districts, and the like.

Once the defenses of such areas have been put out of action, demolition is purely a matter of depositing a sufficient weight of explosives. The RAF, sweeping over Cologne with about 1,000 bombers and night fighters, is said to have wiped out eight square miles. Assuming that of the maximum reported total of 3,000 tons of incendiary and explosive bombs, 2,400 tons consisted of explosive bombs, it would appear that some 300 tons of the latter will ensure virtually complete destruction over an area of one square mile. To destroy Hamburg, then, we should require 15,000 tons. To destroy all of Berlin which is of military interest would require 30,000 tons. These figures may be low, since under the conditions posited there will be considerable wastage, but even with a 50-percent correction the totals remain within reason. Fifteen hundred cargo planes, each carrying 15 tons of bombs, could deposit 22,500 tons on Hamburg; 3,000 planes would be good for Berlin's 45,000 tons. Coventry was blitzed with less than 1,000 tons.

The advantages of the cargo plane for this kind of operation are obvious. Present-day bombers carry comparatively small and unprofitable bomb loads. The B-17E Flying Fortress handles about five tons, the Handley-Page Halifax half a ton more. The largest and heaviest bomber in regular service, the British Stirling, carries a maximum load of eight tons. The experimental Douglas B-19, used as a bomber, is said to have about the same capacity at long range. Of course, as more heavy bombers are built, average loads will be increased, but in the nature of things the unarmed and unarmored cargo plane of equal gross weight will always be able to carry a much greater load.

Cargo planes, moreover, can be produced and operated at comparatively small unit

(Continued on page 218)

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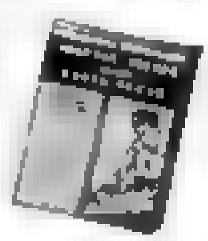

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Cargo Planes for Victory

(Continued from page 216)

cost. A conventional bomber is a precision instrument of destruction. It may have a ceiling of 30,000 feet, a speed of 300 m.p.h., the last word in bombsights, and a crew of from five to ten men, all highly skilled and working together as a team. The loss of the team and plane is one of the small calamities which make up the great calamity of war. Nobody wants to lose a cargo plane either, but, in a military sense, such a loss is comparatively slight. Compared with regulation bombers, cargo planes are expendible. In most cases the crew will consist only of a pilot and a bombardier. Neither need be highly skilled. The planes go out on radio beams; by the time they arrive the city has been set afire by the regular bombing squadrons which preceded them. In good weather the fires can be seen 50 or 60 miles away. Only ordinary proficiency in navigation is called for. As far as the crew is concerned they are simply delivering cargo—cargo which the recipients do not want and which they will certainly not sign for.

Nor does this plan call for precision bombing. All that is necessary is a rough bombing pattern to insure a reasonably even distribution of explosives. A grid may be ruled over the target zone, as shown in an illustration. This forms a kind of template for the cargo bombers. The first bomber discharges its load into Square 1, using a simple bombsight or lead-computer to place the load somewhere in the square. The second bomber discharges into Square 2, and so on. The 11th bomber gives Square 1 another dose, and a few minutes later the 21st bomber follows suit. *Und so weiter.*

The loads called for can be transported to German cities from bases in Ulster, Russia, Iceland, and other regions, should concentration of so many planes in England be deemed inadvisable. Counterbombings must of course be expected and for the present German bases are nearer England than English bases are to German industrial centers. But the Germans have not shown formidable striking power over England for the past year, and it is scarcely likely that they can retaliate on a formidable scale.

From London to Berlin is a flight of about 600 miles. Cargo planes could be used to transport supplies to England, then they could fly to Berlin, drop bomb loads, and go on to Moscow. This would entail a 1,600-mile trip. A shuttle service could thus be operated between Moscow and London via

(Continued on page 219)

Cargo Planes for Victory

(Continued from page 218)

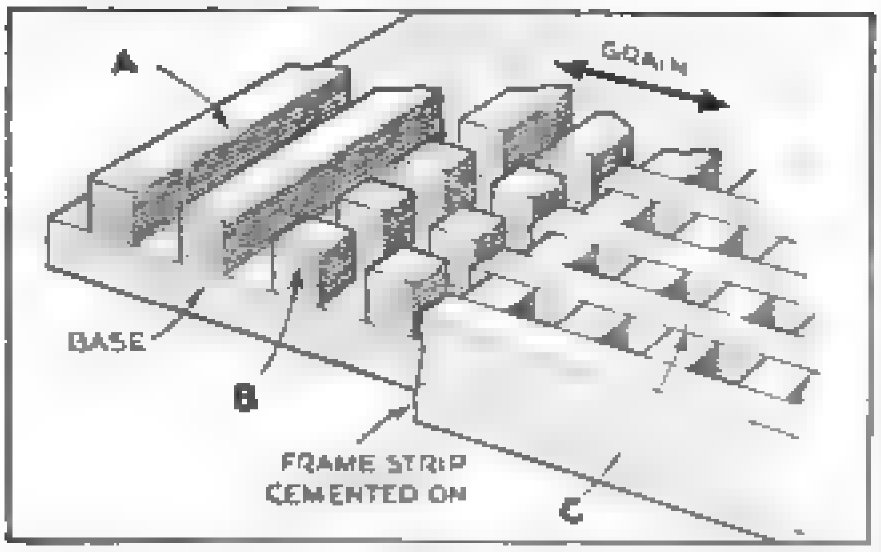
Berlin or other German cities, with several thousand planes in operation at a given time. Some of the newer German industrial centers in East Prussia may be more accessible from Russia than from England. The former Polish port of Gdynia, which the Germans have developed as a naval and a shipbuilding center, is about halfway between Hull and Moscow.

The program outlined does not preclude the opening of a second land front in Europe. If the General Staff should decide on simultaneous land operations, cargo planes can be used as air transports for large bodies of troops—still larger numbers if gliders towed by cargo planes are provided in sufficient numbers. Many other possibilities may be envisioned — cargo planes towing small fighter planes to Europe from the United States, refueling operations carried on in the air, glider trains to carry loads greater than a single cargo plane can pull off the ground, perhaps gliders used for crash landings with bomb loads, etc. The cargo bombers themselves may eventually attain gross weights of the order, not of 30 or 50 tons apiece, as here described, but 175 to 450 tons, with useful loads from 80 to 175 tons, or more.

These are speculative ramifications of the basic idea. New ideas, or new ways of doing old things, will win the war. The Nazis almost won it by military imagination and daring. Now it is our turn.

This is a way to end the war not later than 1943. When the German people lose all confidence in the Nazi regime the United Nations will be appreciably nearer victory. Nothing will disillusion the average German faster than the personal experience of seeing the German air arm and AA defenses incapable of protecting the cities of the Reich from unremitting air attack. Not even Goebbels will be able to talk himself out of a situation like that.

Operations on this scale can level cities and obliterate all life over considerable areas. It is a gruesome picture. A large part of urbanized Europe will be destroyed. But there is no stopping now. If cargo bombing will end the war quickly, whatever devastation is wrought will still be a lesser evil compared with years of stalemate and starvation. Perhaps after such a demonstration the world will finally have learned the lesson that the Ebro does flow through Piccadilly, that peace is indeed indivisible, and that if we want peace and a civilized life we shall have to will the means as well as the end.

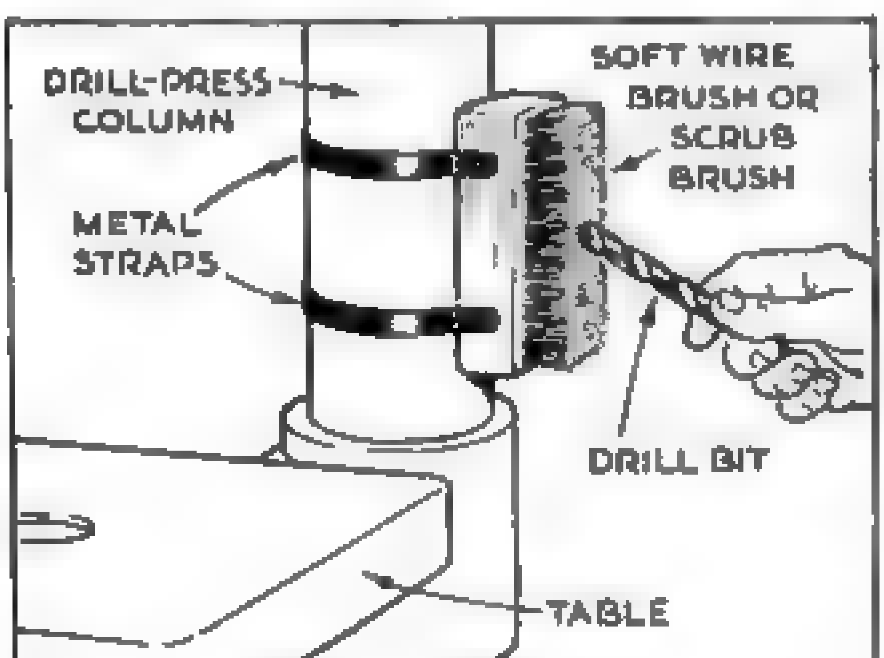


Ship-Model Gratings Built Up from Balsa-Wood Strips

GRATINGS for ship models can be made without a lot of tedious work by the method illustrated. Cut the base to size and cement across it a series of balsa-wood strips *A*, such as are sold for model airplanes. Use an extra strip as a spacer. Clamp or weight the strips while drying.

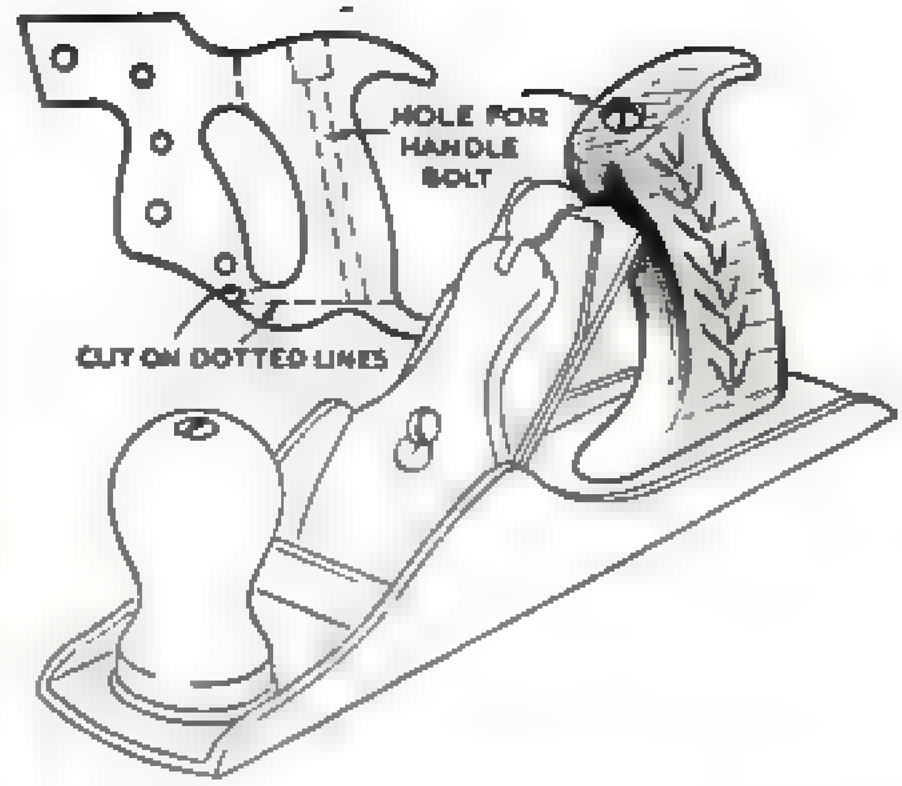
Next, cut the strips crosswise with a thin razor blade as at *B*, chip away alternate blocks with a needle, and clean out the spaces between.

To finish the grating, glue strips in the cross grooves as at *C*, and cement a frame around the edges.—ROBERT LA HAINE.



Brush on Drill-Press Column Removes Chips from Bits

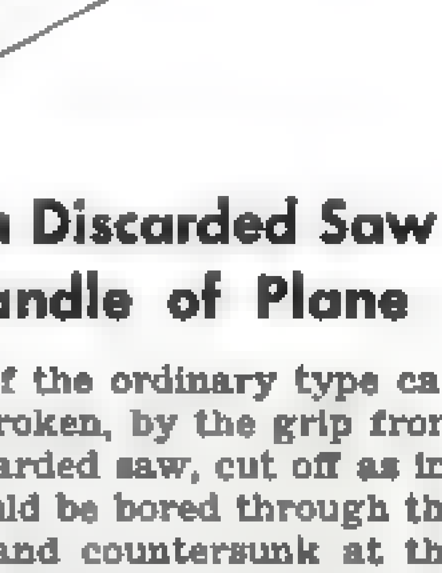
A STIFF-BRISTLED scrub brush or a soft wire brush, fastened to the column of a drill press immediately above the table or in some other convenient location, will save time in cleaning chips from drill bits. The operator merely draws the bit across the bristles. Two metal straps may be used to secure the brush, as shown in the drawing.—W. E. B.



Grip Cut from Discarded Saw Replaces Handle of Plane

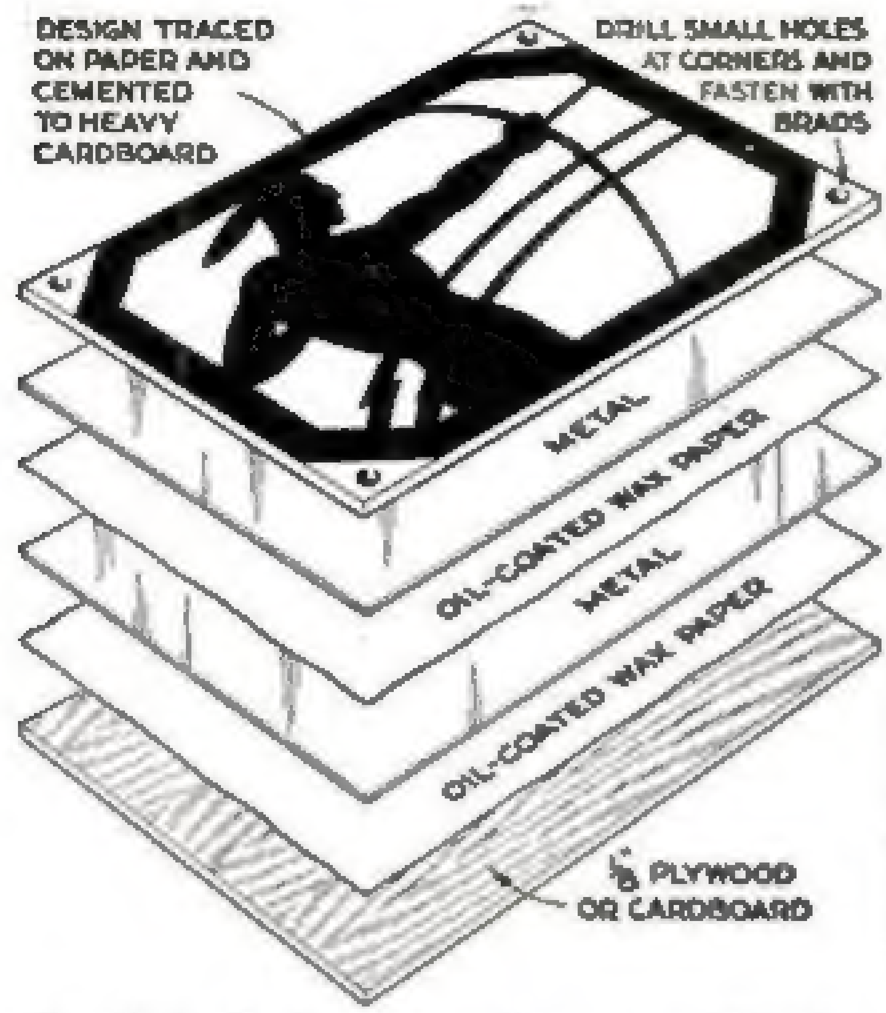
A PLANE handle of the ordinary type can be replaced, when broken, by the grip from the handle of a discarded saw, cut off as indicated. A hole should be bored through the length of the grip and countersunk at the top to take the plane-handle bolt and nut. The two exposed cut surfaces should be rounded smoothly on the sander.—JAMES MANOS.

Wheel of Glass Cutter Serves to Measure Irregular Lines



IRREGULAR lines on maps, patterns, or drawings can be measured with a fair degree of accuracy by the use of a common wheeled glass cutter. Make a reference mark on the wheel with drawing ink or paint. Carefully roll the cutter along a straight line for ten revolutions; then measure the length covered and divide by ten to find the circumference of the wheel. This figure should be marked on the cutter.

To measure a line, begin with the reference mark touching the starting point. Follow the line carefully, counting the revolutions of the wheel. Continue straight past the end of the line until the reference mark again touches the paper. Mark this point. Multiply the circumference by the number of turns. Deduct the distance traveled beyond the line.—ROLAND W. ZIEGE.

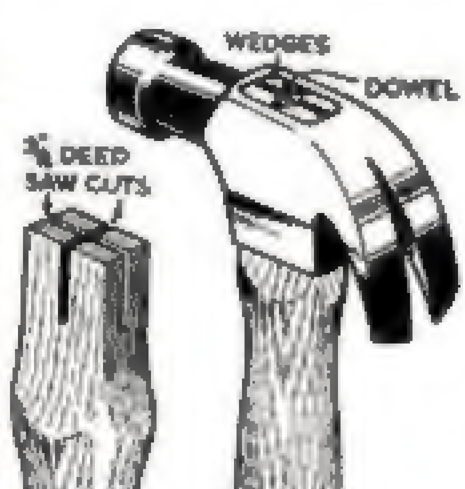


Pad Lubricates Jigsaw Blade in Duplicate Metal Cutting

Two or more pieces of sheet metal or tin plate are easily jigsawed at one time by the method shown in the drawing. Blade breakage is reduced because the oil-coated wax paper affords fresh lubrication along all parts of the cut. Apply a thin film of any ordinary lubricating oil to both sides. Two pieces of 18-gauge soft metal, or more of thinner stock, may be cut at once. A No. 6 jeweler's blade is good for cutting intricate designs. The saw should run at about 500 r.p.m.—ERIC L. BUSS.

Cross-Wedging a Hammer Head

BEING a contractor who uses tools continually, I have found by experiment that the head of a hammer can be fastened solidly to the handle by sawing slots 3/4" deep into the head of the handle lengthwise and crosswise, and driving thin hardwood wedges into the slots —one wedge crosswise and one on each side of the first. The wedges are dipped in glue before being inserted, and the glue is allowed to dry overnight. Next, drill a 1/4" hole 3/4" deep at the intersection. Trim a hardwood dowel so that it is slightly larger than the hole, glue it and drive it in. Cut it flush when dry.—HAROLD R. TERPENY.



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